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increased respiration, sweating in limited, localized areas, and body radiation can compensate for this loss at 84 degrees; but at higher environmental temperatures some rise in body temperature would probably be experienced.

DISCUSSION

The general conclusion to be drawn from these trials is that the application of fly spray augments the relatively small losses attributable to fly annoyance. This conclusion is distinctly at variance with the popular belief that flies exact a heavy toll, which is minimized by spraying.

It is not difficult to see how the dairyman has been led to this belief. The comfortable surrounding and excellent feed conditions that exist naturally in the spring and early summer make this season ideal for milk production. The appearance of flies in greatest numbers is coincident with the onset of summer heat and the drying up of the pastures. It is not surprising then that the dairyman should attribute to flies the marked decline in milk flow caused by hot weather and under-nutrition. Moreover, his faith in the efficacy of fly repellents has been fostered by the sales promotion activities of spray manufacturers and by the advice of certain experiment station and extension workers.

In our studies, the exposure of cows to stable fly infestations many times more severe than would be found under ordinary field conditions (the screened stalls were literally swarming with flies) resulted in less than a ten per cent loss in production. Invariably, however, this loss was about doubled when oil sprays were used to protect the cows, especially in hot weather.

When the average daily environmental temperature remains at 80 or 85 degrees F., depending upon the breed, for more than 24 hours, the heat regulating mechanism ceases to function adequately and the cow exhibits symptoms of distress. At this critical temperature, which we have called the "pyrexial point," her body temperature rises, her milk flow declines, and the physico-chemical characteristics of her milk are altered.

Some critics of our work have failed to distinguish between true burning with its attendant visible lesions, which can be produced by careless application with practically any commercial petroleum fly spray and the less easily observed but more frequently produced condition wherein the body temperature is raised without evident skin lesions following normal spraying.

Shortly after our publication of 1932, (12) Melvin (1932) (6) and later Wilson, Pearson, and Cannon (1933) (8) published the results of numerous experiments covering much the same type of data, in which they confirmed many of our findings; but in reading the temperature of the cows under trial overlooked the fact (already pointed out by us) that above a given "pyrexial point," differing for the breeds, a normal cow, even though unsprayed, cannot control her body temperature. We have shown, quite

clearly, we believe, that oil sprays reduce the amount of osmotic water passing through the skin, thus impairing the efficiency of the cow's thermoregulatory apparatus, in effect, lowering her "pyrexial point," and in consequence, the environmental temperature at which she is able to maintain a condition of comfort.

In studying the results of our first trials (1925), we were inclined to attribute to the mechanical action of the blanket of oil, this increase in body temperature, since we were using at that time, a bland oil, uncomplicated by toxics, having a purity from unsaturates comparable to that of medicinal petroleum. Subsequent trials have always demonstrated two characteristics that refute this idea. In the first place, at least 24 hours must elapse before the feverish condition is noticed. And also, whenever animals exhibiting a body temperature above normal are thoroughly washed with soap and water to remove the spray, their temperatures quickly return to normal only to rise to fever proportions again as soon as the effect of the evaporating water has disappeared. In the absence of further spraying, about a week is required for the animal permanently to resume a normal body temperature.

These facts seem to preclude the possibility of purely mechanical surface action and point strongly to a chemical combination with the tissues. In addition, oils of low unsulfonated residues are certain to produce these unfavorable reactions in a shorter time and with more intensity, a fact which substantiates the theory that the problem is chemical in nature. The striking similarity between the effects of petroleum oils on animal and on plant tissues is perhaps worthy of further consideration.

The kind of spray, the amount applied, the productive capacity of the cows, and the environmental temperature are all important factors in determining the deleterious effect of the spray. This is most marked when the high producing cow is treated with a generous application of a petroleum base spray in hot weather.

In view of the small losses that may be rightfully charged to flies, it is difficult to see how the use of sprays can be justified on economic grounds alone.

CONCLUSIONS

(1) The loss in milk production caused by flies is often overestimated. When high producing cows were exposed to extremely heavy infestations, the loss occasioned by house flies and horn flies was negligible; that caused by stable flies was slightly less than 10 per cent.

(2) Fly sprays of petroleum oils carrying pyrethrum or pine oil or both were tested. All had the same repellent efficiency for the first hour but differed at subsequent intervals. Pine oil increased their efficiency in proportion to the amount added.

(3) Burning of the skin followed the use of oils having a viscosity lower than 40 seconds, irrespective of the unsulfonated residues; while oils with unsulfonated residues below 90 per cent were dangerous, when used in oils of higher viscosity than 65 seconds.

(4) When petroleum sprays were used to repel the stable flies, the loss in milk yield was increased to 22 per cent.

(5) The extreme effect was evident when high producing cows were sprayed during hot weather. Not only was production diminished but the body temperature and respiration rate were elevated. Dry cows exhibited no increase in temperature or breathing rate when sprayed.

(6) The application of oil produces on the skin a definite physiological effect, impairing its ability to aid in maintaining body temperature.

(7) The hourly loss of water through the skin of the unsprayed cow at 84° F. and 60 per cent relative humidity, was 413 grams, while for the sprayed animal this figure was 223 grams. This represents a loss of 46 per cent in cooling, due to the loss in evaporation of water from the skin.

(8) When 40 cc. of commercial spray was applied at an environmental temperature of 80° F., the upper critical temperature or "pyrexial point" of the cow was lowered approximately 5° F.

(9) A water emulsion of pyrethrum and pine oil combined with a small amount of petroleum was as efficient in repelling flies as the petroleum sprays and was less detrimental to the cows.

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SOFT CURD CHARACTER INDUCED IN MILK BY INTENSE SONIC VIBRATION

LESLIE A. CHAMBERS

*The Johnson Foundation for Medical Physics and Department of Pediatrics,
University of Pennsylvania*

The investigations reported by Hill (4, 5), Espe and Dye (3), Elias (2), Weisberg, Johnson and McCollum (7) and others have aroused widespread interest in the use of soft curd milk in the feeding of infants, convalescent gastro-intestinal patients, and even of normal children and adults. It has been demonstrated that curd consistency is an index of the time required for gastric digestion of a given milk. Furthermore, Hill has shown that the average curd texture of milk varies greatly from breed to breed of cattle; that the curd may vary from 15 to 200 grams tension (Hill test) in different individuals of the same herd; and that a variety of factors may cause variations in the curd texture of milk from a single individual. At present many attempts are being made to modify milks of average or hard curd texture by suitable additions, subtractions, or mechanical means. If such modification can be accomplished the product should have real nutritional and clinical value as a special grade of milk, if indeed it has not a practical value wherever fluid milk without further modification is destined for human consumption.

Available and suggested methods for lowering the curd tension of milk are for the most part open to criticism on the ground of adulteration, particularly where some foreign substance such as citrate or metaphosphate is added or where the Ca balance is disturbed by removal through adsorptive or other processes. Curd softening by pressure homogenization is practicable as shown by Theophilus, Hansen and Spencer (6) but seems never to have been employed extensively. Failure to use the method seems to have resulted from milk plant regulations prohibiting the use of homogenizers and from economic considerations.

While investigating the action of intense sonic vibration on the bacterial flora of milk (partially reported elsewhere by Chambers and Gaines (1)), it was found that the curd tension of the vibrated milk was effectively lowered. It is the purpose of this paper to report the results of an investigation of this phenomenon together with certain theoretical and practical implications.

APPARATUS

Two general types of intense sonic energy sources were employed:

1. Electromagnetic oscillators available were similar to those used in submarine communication and echo depth sounding consisting essentially of a

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heavy, loaded, steel membrane actuated by alternation in an electromagnetic circuit (See Figure 1). Three oscillators of this type were available with resonant frequencies of approximately 1200, 2160, and 3000 cycles per second respectively. Power was supplied from appropriate motor driven generators at one half the oscillator frequency since the diaphragms were non-polarized. Input of electrical energy in each case was from 400 to 600 watts depending somewhat on the loading conditions. Actual output of acoustic energy at 1200 cycles was approximately 175 watts while the electrical efficiency of the other oscillators was considerably lower. In fact the acoustic output of the 3000 cycle apparatus was so low that no satisfactory tests could be made at that frequency.

2. Oscillators of the Fessenden type were also used, in which the vibrating membrane is fixed to a copper tube, the whole being polarized by an inciting current of about 2.75 amperes. Movement of the diaphragm depends on reversal of eddy currents in the copper sleeve induced by current oscillations in the activating coil. Consequently the frequency of vibration is equal to the frequency of the activating current and not twice that value as in the electromagnetic oscillators. Two oscillators of the Fessenden type were used, one with a resonant period of about 1090 cycles, the other with resonant periods at 360 and about 610 cycles. Power input was variable

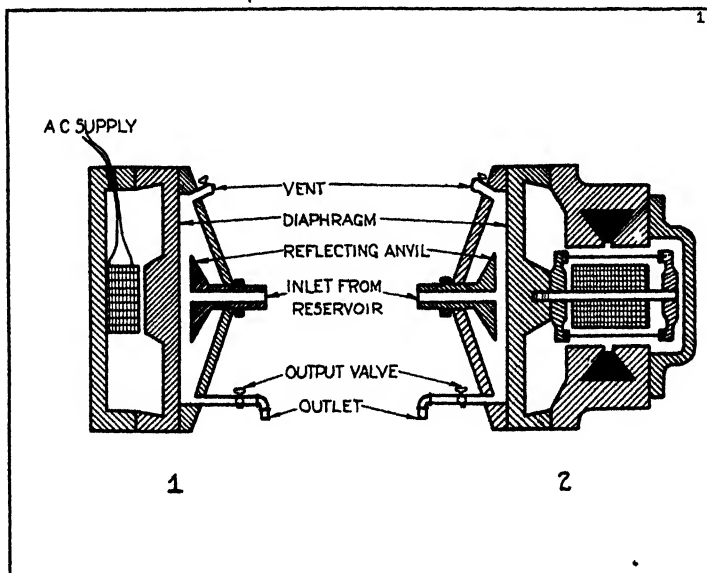


FIG. 1. Diagrammatic sketch showing essential construction features of electromagnetic (1) and Fessenden (2) type oscillators together with accessory apparatus used in applying sonic vibrations to milk. Drawings are not to scale. Oscillators of type 1 were 13½" in diameter while those of type 2 were about 24" in diameter.

up to 2200 watts. The electrical efficiency was about 45 per cent except at the 610 cycle resonance point where the power ratio was somewhat lower.

All the oscillators of both types were manufactured by the Submarine Signal Company of Boston, and, with the exception of the three thousand cycle unit, all are standard equipment in submarine communication and echo sounding work.

Accessory equipment used in securing a uniform application of energy to every portion of milk passed over the oscillator was similar in the two cases. (See Figure 1.) It consisted of a heavy bell metal cover, tin dipped, bolted to the margins of the steel diaphragm. Two marginal openings were provided, one for the ingress or egress of milk and one to enable elimination of an air pocket from the chamber formed between cover and diaphragm. In addition a central opening was provided as an outlet or inlet for milk. This opening passed centrally through a stainless steel "anvil" or reflecting plate capable of micrometer adjustment in such a way that the layer of milk between anvil and diaphragm could be reduced to any desired value up to one half inch in steps of .001 inch. The reflector was three inches in diameter in the electromagnetic oscillator and six to seven inches in the Fessenden type, thus covering most of the strongly active area of the diaphragm. In most experiments the anvil surface, and in a few cases the diaphragm surface as well, were machine scored to increase the turbulence of milk flow over the active area.

Accessory apparatus was also provided for forcing of flow by the application of pressure. This, however, was little used since gravity feed was found to provide as great a flow as could be handled conveniently except where the anvil-diaphragm clearance was less than .040 inch.

EXPERIMENTAL

Most of the milk used in the experiments was obtained from the Deerfoot Farms Dairies of Southboro, Massachusetts. The curd tension of the original supply from this source was regulated within ten gram limits through analysis of the product of each individual in a herd of Jerseys and Guernseys kept at the Farm. With knowledge of the relative curd hardness of milk from individual animals it was possible to obtain hard, medium or soft curded samples at will. In addition, bulk milk, both raw and pasteurized was supplied by the same dairy from mixed herds, presumably largely of Holstein origin.

To insure a representative study samples of milk were also secured from five other sources in the Boston milkshed area. No differences in the behavior of the various milks were detected which could have been accounted for by difference of source.

The curd tensions of the approximately 500 samples taken over a period of eleven months varied between 14 and 140 grams. An interesting con-

firmation of Hill's observation that harder curded milk is produced during cold than during warm weather resulted from this series of determinations. During July and August the average tension of all mixed samples was about 32 grams while the onset of cool weather brought a gradual rise until the average figure for November and December was 63 grams. Daily fluctuations in the curd tension of mixed milks paralleled roughly the fluctuations in average daily temperature.

The Hill technique (5) was used in the determination of the curd tension in all cases. Great care was exercised in maintaining the water bath temperature constant within ± 0.2 of a degree as it was found that greater variation resulted in large errors. As insurance against possible faulty technique a number of samples were sent to the National Dairy Laboratories in Baltimore. The measurements made by Doctor Weisberg checked our own within five grams. Greater accuracy could be of little value in this study.

While variations were introduced in individual experiments the general method of handling the milk before, during, and after exposure to vibration was as follows:

1. Milk was warmed or cooled to the desired temperature in a water bath.
2. The oscillator and accessory equipment including all surfaces with which the milk might come in contact were thoroughly cleansed and then warmed to the desired temperature by flowing hot water through the system.
3. After control samples were taken the milk was placed in the reservoir and the oscillator chamber allowed to fill. Usually any air pocket remaining in the chamber was excluded by opening the vent. (See Figure 1.)
4. Vibration was begun and the rate of flow of milk adjusted by regulation of the outlet valve.
5. Samples were taken only after sufficient time had elapsed to insure complete removal of milk originally introduced into the oscillator chamber.
6. The samples were placed in the water bath at 35° C. for immediate test, or were stored at 10° C. for delayed tests. A difference of 24 to 48 hours in elapsed time resulted in no significant change in the curd tension either of treated or untreated samples.
7. In most cases 100 cc. samples were stored at 10° C. in graduate cylinders for measurement of cream volume after 24 hours.
8. Microscopic examination of treated and untreated samples was made to determine relative average and maximum fat particle size and relative degree of pedesis.

EXPERIMENTAL RESULTS

Qualitatively the results of vibration of milk with the two types of oscillator were closely parallel. Consequently the task of summarizing the data of more than 600 experiments can be simplified by considering the extent of curd reduction with respect to energy input, volume, and temperature

for the entire group of oscillators at the same time, indicating those points at which significant divergences exist. No useful purpose would be served by including detailed protocols of all experiments. Instead significant averages over large groups of related experiments will be utilized together with indications of the extremes of individual measurements.

Extent of curd reduction in 3.5-1 per cent milk

Much of the experimentation was of an exploratory nature to determine the effect of all possible variations in method of handling on the degree of change in curd texture. Attention was given to variations in rate of flow through the oscillator, temperature of the milk during exposure, electrical energy output to the oscillator, acoustic energy output of the oscillator (where feasible), curd tension in the untreated milk samples, the degree of dispersion of the butter fat, and clearance between reflecting anvil and oscillator diaphragm. These will be taken up in order:

A. Reduction in curd tension as a function of exposure time (rate of flow).

All other variables remaining constant the degree of reduction in curd tension is a rather complex function of the velocity of milk flow through

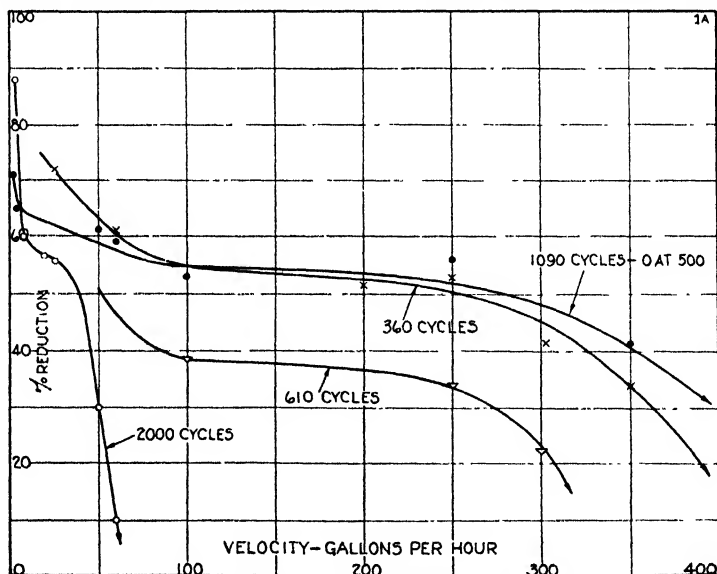


FIG. 2a. Variation in % R ($= 100 - \text{Final tension} / \text{Original tension}$) with respect to rate of flow (velocity) through three different oscillators, one of which was operated at two frequency levels (360 and 610 cycles). All points represent averages derived from experiments on both hard and medium curd milk. All samples were preheated to $40^{\circ} - 60^{\circ}$ C. Power inputs were: 1800 watts at 1090 cycles, 1400 at 610 cycles, 1900 at 360 cycles, and 600 at 2000 cycles.

the oscillator. (See Figure 2.) In the larger Fessenden oscillator with essentially equivalent power inputs this peculiar relationship becomes apparent only at velocities greater than 100 gallons per hour. At less than 100 gallons per hour velocity is an exponential function of the percentage reduction in curd tension. From 100 to about 250 gallons per hour the relationship becomes linear with zero slope. At higher velocities the curve is such that no reduction in curd tension is produced when the flow exceeds 500 gallons per hour.

The actual values of % R (per cent reduction in curd tension) differ somewhat at the three frequency levels available with the Fessenden oscillators (cf. Figure 2A), *i.e.*, 360, 610, and 1050 cycles, but the shape of the curve remains sensibly constant. Variation in position with respect to the % R axis is explainable on the basis of relative electrical efficiency at the three frequency levels. The 360 cycle oscillator with an efficiency of 45-47 per cent at resonance delivers more acoustic energy than does either of the remaining units, power consumption being held at the same level in all three cases.

As indicated by the curve (Figure 2A) the average reduction in curd tension at power inputs of 1800 watts to 2200 watts varied as follows:

GALS./HOUR	% R AVERAGE	% R EXTREMES
25	73%	53% - 78%
100	52%	40% - 69%
250	53%	35% - 70%
350	34%	25% - 51%

These values cover experiments with a variety of clearances between anvil and diaphragm, various temperatures between the melting point of butter fat (35° C.) and 60° C., and include studies on both medium curd (30-60 grams) and hard curd (above 60 grams) milks. The effect of these variables on the net result is relatively unimportant as will be seen later, except for the difference in values for hard and soft curd milks. Figure 2B includes curves showing the average tension reductions for the two general groups when averaged separately. Medium curd milk at comparable rates of flow shows a smaller percentage reduction than does milk in the hard curd group. It is interesting to observe that this relative ease of reduction has been found to hold for curd tension changes produced with the standard pressure homogenizer.

From the extensive available data it is apparent then that the velocity at which maximum efficiency of curd reduction is attained at a given power input is approximately 250 gallons per hour where the 360 cycle oscillator is used. The same values have been found to hold true for the Fessenden oscillator operated at 1050-1125 cycles. The physical conditions

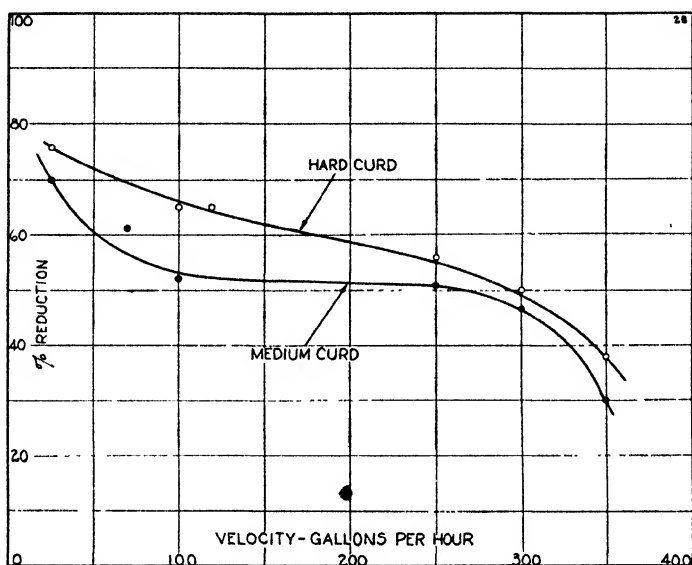


Fig. 2b. Variation in % R with respect to velocity in milks of the medium (30-60 gram) and hard (60 grains and up) curd groups. Treated at 360 cycles, 1900 watts, 50° - 60° C.

of treatment were identical with the exception of frequency and reductions in curd tension differed from those obtained at 360 cycles by only one or two per cent over the entire range of velocities.

Comparison is more difficult in so far as the 610 cycle oscillator is concerned since the possible power input at this frequency was limited to about 1400 watts. However, the general shape of the curve was quite similar to that obtained with the two preceding frequencies.

The significance of the plateau in the characteristic velocity curve for these three types of oscillators is not quite clear. However, it is probably produced by variations in the degree of turbulence in the oscillator chamber at different velocities of flow.

The relation between percentage reduction and velocity in the electromagnetic oscillators (1150 cycles, 2160 cycles, and 3000 cycles) are of the same general type as reported above, the only significant differences lying in the position of the plateau region relative to the velocity axis. Thus in both the 1150 and the 2000 cycle oscillators the portion of the curve with zero slope falls between 12 and 25 gallons per hour, while only negligible reductions in curd tension are obtained at 65 to 70 gallons per hour. It should be remembered however that the power input in these two cases was invariably less than 600 watts and further that the electrical efficiency of the two oscillators is only about half that of the large 360 cycle Fessenden.

B. *Extent of reduction as related to temperature.*

With all types of oscillators reduction in curd tension of ordinary whole milk was accomplished only when the milk was heated to a temperature higher than the melting point of butter fat, that is, above 35° C. No reduction of any measureable extent was ever accomplished in milk treated below 18° C. Figure 3 is a typical curve relating the percentage reduction

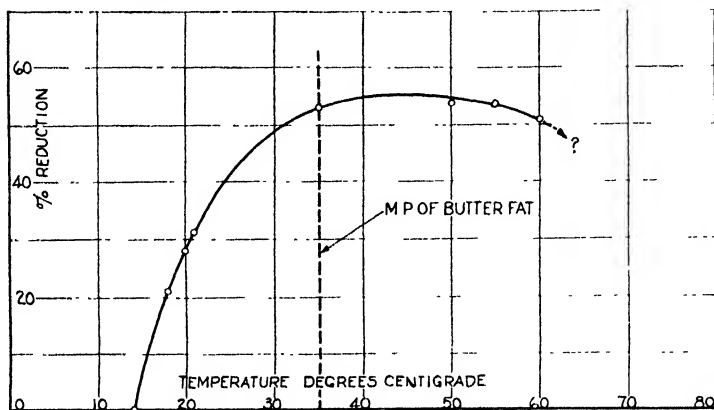


FIG. 3. Variation in % R with respect to temperature of the milk during vibration. Treated at 250 gallons per hour, 1900 watts, 360 cycles.

in curd tension to the temperature of treatment. It will be noted that an optimum temperature was reached at 35° and that increase up to 55° resulted in no further increase in efficiency of the process. There seems to be a tendency toward reduced effectiveness when the treatment temperature is greater than 55°.

In general it can be said that there is no curd tension reduction below 18°, very little between 18° and the melting point of butter fat, while a maximum reduction is obtained at temperatures above the melting point.

C. *Extent of reduction as related to power input.*

The most extensive studies of the relation between degree of change in curd texture and the amount of power applied have been made in the case of the 360 cycle oscillator. The relationship is best shown in Figure 4, where it will be seen that power input is an approximately linear function of the percentage reduction in curd tension up to a maximum of about 1900–2000 watts. At inputs greater than 2 kilowatts there is no further rise in efficiency. The curve was derived from averages of all samples treated in the oscillator, including both hard and medium curd milks, at 250 gallons per hour and at temperatures above 35° C. The significant average points together with extreme values are as follows:

INPUT	% R AVERAGE	% R EXTREMES
700 watts	25%	5% - 35%
1400 watts	45%	24% - 62%
1900 watts	56%	35% - 72%

If, as in the broken line curves, the hard curd and medium curd values are plotted separately it will be seen that the percentage reduction in the former group is considerably greater than in the latter group. Thus at 1900 watts the extreme low reading in the hard curd group represented a 45 per cent decrease in curd tension as compared with an extreme low of 35 per cent in the medium curd group. This simply means that the final curd values in terms of grams are approximately the same regardless of the original curd hardness, a point of considerable practical importance. Taking the average for all groups (solid curve), the slope between 700 and 1900 watts input is such that approximately 37 watts input is required to bring about a decrease of one per cent in curd tension at the designated velocity (250 gallons per hours). Since the efficiency of the particular oscillator is approximately 47 per cent it follows that roughly 18 watts of acoustic energy must be available in order to bring about one per cent reduction in curd tension.

In the case of the 610 cycle Fessenden oscillator most of the experiments were performed at 1400 watts input. The average reduction in curd tension at 250 gallons per hour in this case was about 34 per cent compared with 46 per cent at 1400 watts in the case of the 360 cycle oscillator. However, the lower order of efficiency obtained at the higher frequency results

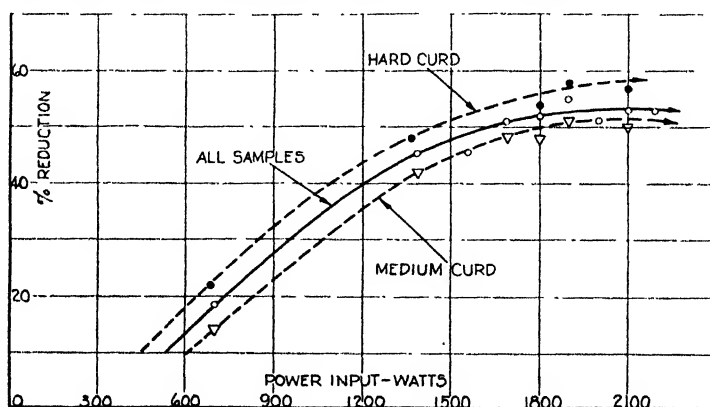


FIG. 4. Curve showing the relationship between % R and the power input to the 360 cycle oscillator with a maintained milk flow of 250 gallons per hour. The solid line represents an average of all types of milk while dotted lines indicate average values obtained in the medium and hard curd groups. All samples were preheated to 50° - 60° C.

in an acoustic output ratio of about 18 watts to each one per cent reduction in curd tension, a figure identical with that obtained at the lower frequency.

In the case of the electromagnetic oscillators, power ratios were not so significant because of the relatively low velocities and consequent high degree of error in measurement and because of the relatively greater influence of uncontrolled variables, such as the amount of included air in the milk. However, the ratio of acoustic output in watts to percentage reduction at a fixed rate of flow seems to be of the same order of magnitude as in the larger oscillators.

D. Degree of reduction as related to frequency.

Studies summarized in the above paragraphs relative to the dosage requirements with the different types of oscillators indicate quite conclusively that the frequency of vibration is not a function of the degree of curd tension reduction obtained over the range explored, *i.e.*, from 360 cycles to 3000 cycles. The 3000 cycle oscillator failed to give any appreciable reduction in curd tension, but this fact must be interpreted in terms of the extremely low electrical efficiency of the oscillator. The frequency band explored is so narrow that slight differences may have escaped attention.

E. Extent of reduction as related to original curd tension.

As is the case where curd tension is reduced by pressure homogenization, the vibration treatment produces a greater decrease in hard curd than in medium curd milks. The different average values for the two general groups have been indicated above in connection with studies on velocity and energy relationships.

The disparity in amount of reduction naturally implies a tendency for all samples of milk to assume similar actual values in terms of grams curd tension when subjected to identical conditions of handling and treatment. As a matter of actual record in more than 150 samples of milks varying between 28 and 110 grams original curd tension handled under identical conditions the final tension values fell below 18 grams in but 2 instances and above 32 grams in not more than 5 instances.

F. Degree of reduction as related to fat dispersion.

The original observations of curd tension reduction in milk were made during the course of efforts to homogenize the butter fat with the 1200 cycle electromagnetic oscillator. At the low velocities of flow possible under the conditions of the experiment it was found that the degree of curd tension reduction was a linear function of the average diameter of fat particles resulting from the dispersive action of the oscillator. The relationship is illustrated in Figure 5 in which the average relative particle

sizes resulting from all individual experiments with the particular oscillator are plotted against the percentage of original curd tension remaining in the treated milk.

On the other hand when the larger oscillators of greater capacity were used no such relationship between average particle size and degree of change in curd texture was found. Indeed microscopic examination of the milk after treatment at 250 gallons per hour with a frequency of 360 cycles repeatedly failed to indicate more than a slight reduction in average particle size although the reduction in curd tension, as shown previously, never amounted to less than 35 per cent and in many case was greater than 60 per cent.

Reductions in average fat particle diameter of the order indicated in Figure 5 should result in proportionate reductions in the cream volume

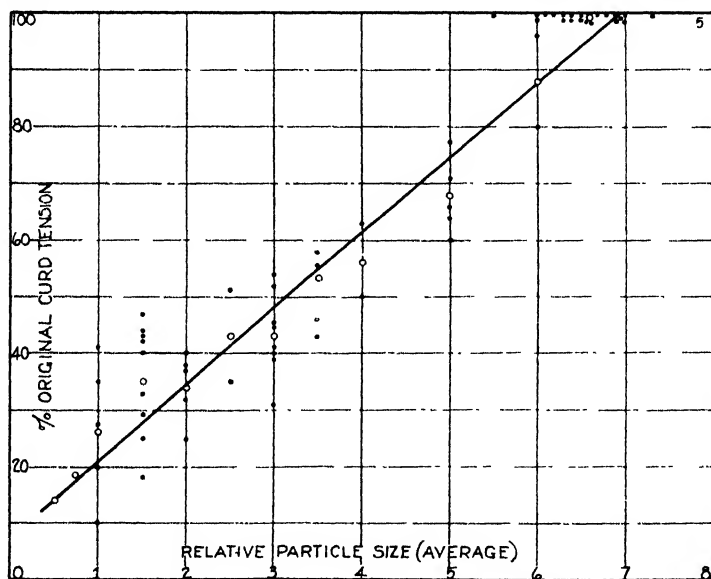


FIG. 5. Relationship between average relative fat particle size and per cent of original curd tension in samples treated at 1090-1140 cycles in small electromagnetic oscillator. Initial average diameter was set at 6-7 to establish the scale. In all cases the rate of flow through the oscillator was low, being restricted by extremely small clearances between reflecting anvil and diaphragm.

and such was found to be the case. Where the particle size was reduced to an average of $1.5\ \mu$ or less there was no cream formation even after standing 48 hours at 10° . With an average diameter of $3-4\ \mu$ the cream volume was reduced to the extent of about 60 per cent. From this observation in the case of the small 1200 cycle oscillator it was expected that milk

treated in the 360 cycle oscillator would show little if any change in cream volume. Paradoxically the expectation was found to be erroneous. As a matter of fact in most cases, even those in which little change in fat particle diameter could be observed microscopically there was an impairment of cream volume. The fat was slow to rise and the final volume was less than that of the untreated milk by from 25 to 100 per cent. These observations were checked by Doctors Whitaker and Weisberg of the National Dairy Laboratories. In addition Doctor Whitaker determined that the reason for the failure of treated milk to form a cream layer or to separate rapidly lies in a failure of the fat particles to agglomerate normally. No explanation of this latter phenomenon is available at present.

Additional evidence relative to the role of dispersed fat in determination of curd texture was obtained from experiments based on the vibration of skim milk and milk from which the original fat had been partially removed. The samples of skim milk used were obtained from various commercial sources. When treated under the usual conditions (250 gallons per hour, 360 cycles, 2000 watts) the samples showed considerable variation in susceptibility to vibration in so far as curd texture was concerned. In about half of the cases no reduction in tension was recorded while the remainder showed reductions ranging from about 10 per cent up to the average value obtained under similar conditions in whole milk. Figure 6

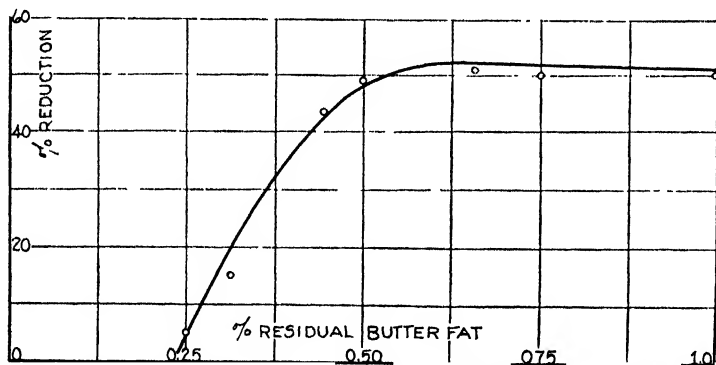


FIG. 6. Percentage reduction in curd tension of skim milk with respect to residual butter fat concentration when treated at 25 gallons per hour, 500 watts in small 1090 cycle oscillator. Temperature 50° C. No reduction was obtained where the fat concentration was less than 0.25 per cent.

indicates the manner in which the percentage reduction in curd tension varied with the concentration of residual butter fat. (The figure is derived from experiments on the 1090 cycle oscillator at 500 watts and a flow of 25 gallons per hour.) With fat percentages less than 0.25 little or no change in curd texture was obtained. From 0.25 per cent to the maximum

of about 0.65 per cent the degree of reduction increased directly with fat concentration. Particularly interesting is the observation that the same order of reduction was obtained at a fat concentration of 0.65 per cent as was observed in whole milk.

As a further check on the role of fat particles in determination of curd texture the following experiment was carried out. A sample of skim milk was centrifuged at high speed to reduce the residual fat to about 0.01 per cent. To this was added 29 per cent cream to bring the fat concentration to values of 0.25, 0.5, 1, 2, 3, 4, and 10 per cent, after which addition the curd tension was measured. To another portion of the skim milk sample was added the same amounts of 29 per cent cream previously homogenized. The dispersion of fat in the second cream sample was such that it contained 1000 times as many fat particles and offered 10 times as much surface as did the unhomogenized cream used in the first series. The accompanying figure (Figure 7) shows the relationship between the percentages of fat in the two cases and the final curd tension values. With homogenized cream approximately the same value was obtained at 0.25

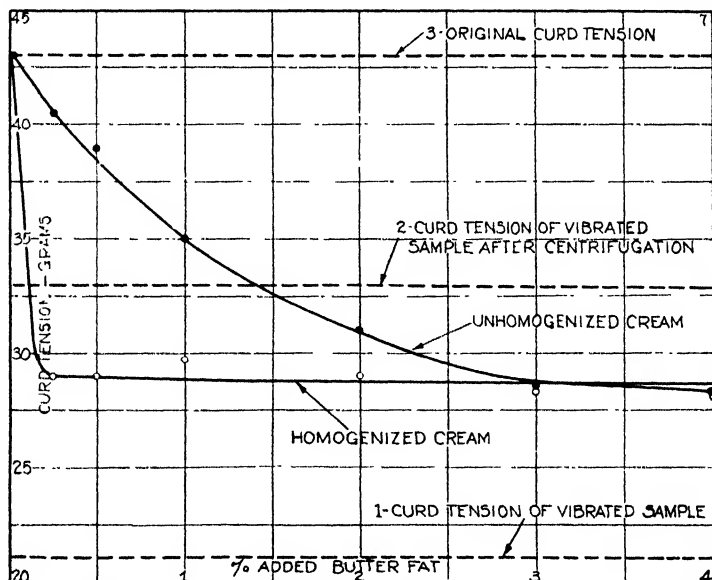


FIG. 7. Curves showing the effect of added butter fat in the form of 29% cream, homogenized and unhomogenized, on the curd tension of a skim milk sample of 0.01% residual fat concentration. The homogenization was such that a particle number ratio of 1000/1 existed between the two cream samples. Horizontal dotted lines indicate (1) the curd tension obtained by vibration of the 3% unhomogenized mixture, (2) the curd tension arrived at by centrifugation of the vibrated sample to the original 0.01% butter fat, and (3) the original curd level of the 0.01% skim sample.

per cent butter fat as at any higher concentration. With unhomogenized cream the drop in curd tension was much less abrupt, the limiting plateau level being attained only after addition of 3 per cent of fat. The number of fat particles present per unit volume of milk is therefore an important function of the curd texture.

It was suspected that increased adsorption and fixation of casein or other polar constituents incident upon the great increase in fat surface available for such adsorption when the particles are subdivided *in situ* either by homogenization or by vibration might play an additional role in the curd tension reduction. To check such a possibility a sample of the same milk used in the experiment above, to which had been added 3 per cent of unhomogenized butter fat in the form of 29 per cent cream, was passed through the small 1200 cycle oscillator at a flow of 25 gallons per hour. The curd tension after treatment was 21 grams as compared with the 29 gram value obtained by simple addition of the butter fat. After the vibration treatment the milk was centrifuged in such a manner as to bring the butter fat value back to the original 0.01 per cent of the basic skim sample. Whereas the initial tension was 43 grams, the final tension after removal of the butter fat subdivided *in situ* was only 35 grams. This fact probably indicates a permanent fixation of part of the originally dispersed casein or calcium caseinate on the enhanced fat surface and its subsequent removal from the milk along with the fat itself. Unvibrated 3 per cent milk when centrifuged was returned to the original curd tension value (43 grams).

From the above experiments it seems to follow that the reductions in curd tension of milk obtained with the larger as well as the smaller oscillator is dependent on either increasing the number of fat globules without reference to increased absorptive surface, or on elimination of casein from the coagulation complex through increased surface absorption and fixation, or both. In any case it seems obvious that the required increase in particle number of available surface may be obtained by subdivision of a relatively small proportion of the total number of particles present in whole milk.

As a further check on this theory and for practical reasons attempts were made to produce by vibration at 360 cycles per second, a soft curd milk in which the cream volume was not impaired. In the accompanying table (Table I) the results of these efforts are set forth. The whole milk in each case was allowed to stand in the holding tank at 10° for from two to four hours during which time gravity separation of cream was accomplished to the extents indicated. The lower four-fifths of the milk was then passed through the oscillator at 250 gallons per hour after heating by means of a water bath to a temperature of 50°. Thus only $\frac{1}{5}$ to $\frac{1}{4}$ of the fat which would normally appear as cream in twenty-four hours was

TABLE I

Protocols of three experiments in which satisfactory reduction in curd tension was obtained without eradication of creaming by partial gravity separation, treatment of the relatively fat free portion, and subsequent addition of the fat rich portion

	TYPE OF SAMPLE	VELOCITY GALS./HR.	FREQUENCY CYCLES/SEC	POWER INPUT WATTS	CURD TENSION	RELATIVE CREAM VOLUME
EXP. I 4 hours gravity separation	Whole Milk	250	360	2000	74	7/16
	Lower $\frac{1}{2}$				75	3/16
	Upper $\frac{1}{2}$				58	
	Lower $\frac{1}{2}$ (vibrated)				24	
	Vibrated $\frac{1}{2}$ plus Upper $\frac{1}{2}$				28	9/16
EXP. II 2 hours	Whole Milk	250	360	2000	70	8/16
	Lower $\frac{1}{2}$				72	5/16
	Upper $\frac{1}{2}$				55	
	Lower $\frac{1}{2}$ (vibrated)				25	
	Vibrated $\frac{1}{2}$ plus Upper $\frac{1}{2}$				31	7/16
EXP. III 4 hours	Whole Milk	250	360	2000	66	7/16
	Lower $\frac{1}{2}$				75	2/16
	Upper $\frac{1}{2}$				33	
	Lower $\frac{1}{2}$ (vibrated)				27	
	Vibrated $\frac{1}{2}$ plus Upper $\frac{1}{2}$				29	9/16

exposed directly to the vibration. The supernatant cream layer was added to the treated residuum immediately but was not passed through the oscillator while the power was on. In two of the three experiments the cream volume after twenty-four hours was slightly less than normal. In the third case the volume was rather markedly increased. This last result was doubtless due to the fact that the milk was allowed to stand for a shorter time before treatment of the "skim" layer thus resulting in vibration treatment of a larger proportion of the butter fat. The creaming situation was comparable with what may be expected from partial homogenization in a commercial pressure device.

The significant indication of the above experiment is that dispersion of a relatively small part of the total butter fat content of whole milk results in as great reduction in curd hardness as does vibration of the whole milk. From this it follows that the production of soft curd milk by vibration without consequent elimination of the creaming property is practicable.

G. *Degree of reduction as related to mechanical factors.*

Figure 8 indicates the manner in which the extent of curd tension reduction varied with variations in clearance between the reflecting anvil

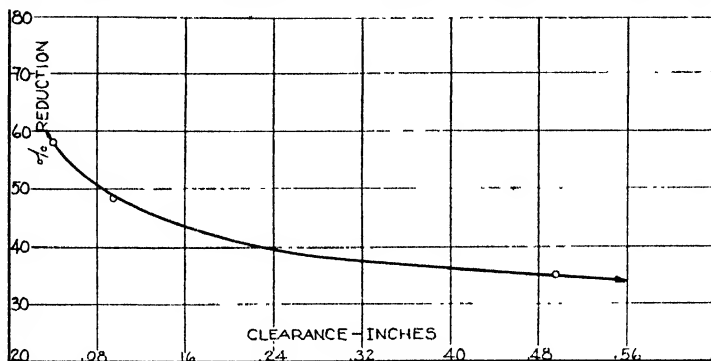


Fig. 8. Curve showing relation between anvil clearance (thickness of exposed milk layer) and % R in 360 cycle oscillator operated at 1900 watts with a milk flow of 250 gallons/hour. The standard flow could not be attained with clearances less than 0.04 in.

and the diaphragm. All points represent averages derived from samples subjected to identical treatment with respect to power input (1900 watts), velocity (250 gallons per hour), temperature (50°), and frequency of vibration (360 cycles per sec.). Under the conditions of the experiment it was impossible to maintain an adequate flow without resorting to pressures above atmospheric at clearances below .040 inches. It is obvious that greater efficiency is attained when the layer of milk between the rigid and the actively vibrating members is thin. The most practicable clearance was found to be about .100 inch, while .500 inch seems to represent a limit beyond which there is very little further decrease in effectiveness.

It should be recalled that the averages used in the previous relationships (velocity, power, et cetera) are based on experiments covering the entire range of clearances between .040 and .500 inches. This accounts for part of the wide variation in curd tension observed under otherwise identical conditions of exposure.

Other variations in the mechanical set-up of the large Fessenden oscillator (360 cycle) such as scoriation of anvil or diaphragm or both to increase turbulence have not been found to exert any measurable influence on efficiency of the apparatus.

In addition to the above mentioned physical experiments certain biological tests have been undertaken with the vibrated milk. These are not completed as yet but indicate tentatively that soft curd milk produced by vibration differs in no qualitative respect from the similar product produced by pressure homogenization. This in itself furnishes further indica-

tion that the mechanisms in the two cases are similar and that the alteration of curd in both cases is dependent upon increase in adsorptive surface and consequent shift in the calcium/casein equilibrium by fat dispersion.

The flavor and odor of the vibrated milk has been found normal. Furthermore no precipitate of any consequence has been observed in the treated milk even after forty-eight hours of standing.

DISCUSSION

The majority of published studies on the factors influencing the curd texture of milk have concerned themselves with the causes of variations in normal unaltered milk. In general these investigations have attempted to show that the curd texture is primarily related to the concentration and distribution of casein, soluble calcium, and to a limited extent, butter fat. The role of calcium can scarcely be considered inasmuch as a great excess of calcium chloride is normally added before the Hill test is made.

A complete exposition of the theoretical implications of the experiments recorded in this paper cannot be attempted here. However, the results seem to demonstrate that the sonic vibration acts directly on the butter fat of the milk causing a more complete dispersion and consequently increasing the specific surface. Thus a larger proportion of the available protein is adsorbed and fixed in such a way that it no longer influences the coagulation complex.

In addition to the removal by fixation of a portion of the total protein from the serum, the dispersion of fat seems to affect the curd texture directly, probably by providing points of weakness in the final curd matrix. This mechanical influence is apparently negligible as compared with the more indirect factor of increased surface. Reductions obtained by the simple addition of butter fat in the form of cream to skim milk never amount to more than 15-18 grams no matter what the initial tension of the skim sample, the percentage of added fat, or the state of subdivision of the fat. Fat added in this way does not provide additional adsorptive surface so its effect is probably entirely mechanical. The situation is different in every respect except that of particle number from that obtaining when the fat is subdivided *in situ*.

The evidence favoring the theory that the curd tension reducing action of sonic vibration is entirely a dispersive action on the butter fat may be summed up as follows:

1. The curd tension of skim milk of less than 0.2 per cent butter fat is not changed by vibration.
2. The curd tension of milk containing more than 0.25 per cent butter fat may be reduced by vibration at a temperature higher than the melting point of butter fat but no change can be effected below that temperature.

3. The reduction of curd tension in skim milk by addition of heavy cream is proportional to the number of added fat particles and bears no direct relationship to the actual fat concentration.

4. The vibratory subdivision of butter fat *in situ* results in a permanent lowering of the curd tension even after the fat has been removed by high speed centrifugation. Thus the adsorptive action of the increased fat surface is demonstrated to be an important factor.

The failure to observe any appreciable degree of fat dispersion in milk treated in the 360 cycle oscillator may not be admitted as contrary evidence. It must be remembered that the subdivision of as little as 0.25 per cent of butter fat in a milk sample brought about as great a reduction in tension as was accomplished by the action of the vibrator on whole milk. Under the crude conditions of observation and measurement of particle diameters subdivision of less than one-eighth of the total number of particles would have little influence on the average particle values recorded. It should be pointed out that there was always more Brownian movement to be observed in the treated samples than in the control milk. Incidentally the average particle diameters used throughout this report represent only relative values since calibration of the micrometric apparatus was carried out very roughly. Knowledge of the absolute values would be of no importance in this study.

From a practical viewpoint the sonic method of producing curd tension reductions in milk is of interest. The apparatus is simple, both in construction and operation, relatively inexpensive in initial cost and in operation, and easily conformable to the operating requirements of the average milk plant. The simple construction of the vibrator unit makes it desirable from the viewpoint of the sanitation engineer. In addition the method can be adapted either to markets in which a normal cream volume is demanded, or to those in which the sale of homogenized milk is the usual and accepted practice.

SUMMARY

Reduction in the curd tension of milk was accomplished by flowing the fluid in a thin layer over electromagnetically driven diaphragm sources of intense sonic vibration.

A study was made of the curd reducing effectiveness of oscillators operating at 1100, 1200, 2160, 3000, 610, and 360 cycles as related to original curd tension of the milk, temperature, time of exposure (velocity of flow), acoustic energy output, and variations in the mechanical features of the apparatus.

The percentage reduction in curd tension was greatest in hard curd (60 grams and more) milks. Final curd values approached a constant level in the soft curd range no matter what the original curd texture.

No reduction in curd tension was obtained in milk treated below 18° C. and very little at temperatures below the melting point of butter fat.

It was found that one of the oscillators (360 cycle) was most efficient when the milk flow was maintained at 250 gallons per hour. With a sound output of about 900 watts more than 50 per cent reduction was attained.

With the 360 cycle oscillator the degree of reduction in curd tension was found to bear a direct linear relationship to the power input up to 2000 watts when the velocity was 250 gallons per hour. This represents an output of about 18 watts per one per cent decrease in tension. Other oscillators at different frequencies showed much the same effectiveness with equivalent outputs per unit volume of milk. Hence differences in frequency were found to be negligible within the range explored.

A direct relationship was found to exist between degree of fat dispersion and degree of curd tension reduction. The increased number of fat particles was shown to influence curd texture by weakening the curd matrix and by providing increased adsorptive area on which protein was fixed.

Since but a small proportion of the total fat in milk need be finely subdivided to reduce the curd tension, a method was devised for producing soft curd milk by vibration without impairing the final cream volume.

ACKNOWLEDGMENTS

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THE INFLUENCE OF FOOD FAT OF VARYING DEGREES OF UNSATURATION UPON BLOOD LIPIDS AND MILK FAT

L. A. MAYNARD, C. M. MCCAY AND L. L. MADSEN
Laboratory of Animal Nutrition, Cornell University

For several years this laboratory has been engaged in an investigation of the secretion of milk fat by studies of the interrelationships between the kind and amount of food fat, the distribution and character of the blood lipids and the nature and amount of the fat secreted. Both cows and goats have been used in these studies. The present paper reports a continuation of this work and describes results obtained where the distinguishing feature of the rations was the degree of unsaturation of the fat component.

Holstein cows were fed in alternate periods rations containing fat of high and low iodine number, by varying the character of the grain mixture. The same ingredients were used in each mixture with the exception that 10 per cent of ground flaxseed was included in the mixture designed to furnish fat of high iodine number and that 30 per cent of cocoanut oil meal was present in the mixture supplying the fat of low iodine number. The other ingredients were varied in amount to provide 20 per cent of protein and the same content of total digestible nutrients in both mixtures. The cocoanut oil meal mixture contained 6 per cent of fat having an iodine number of 26, while the other mixture contained 6.5 per cent of fat with an iodine number of 137.

Each cow was fed the same amount of mixed hay and silage throughout the experiment, but the grain allowance was varied in accordance with production. On the basis of the amounts of each feed fed, its fat content and the iodine number of this fat, the fat intake and its iodine number for the ration as a whole were calculated. The feeding system was as follows:

Cow	Period 1	Period 2	Period 3
	20 days	20 days	10 days
E	Low I. No. ration	High I. No. ration	Low I. No. ration
C	High I. No. ration	Low I. No. ration	High I. No. ration

The changes in the ration from one period to the next were made abruptly.

The cows were milked twice a day. The fat and its iodine number were determined on two-day composites, periodically throughout the experiment. Immediately prior to a change of ration and for four or five days thereafter these determinations were made on the composite of each day's production. Blood samples were taken from the jugular vein three times in each period. The plasma was used for the determination of total lipids and their iodine

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number, lipid phosphorus and cholesterol. The methods were the same as those used previously (1).

RESULTS

The data showing the changes in the character of the milk and blood fat are plotted in charts 1 and 2. The striking feature of these data is the

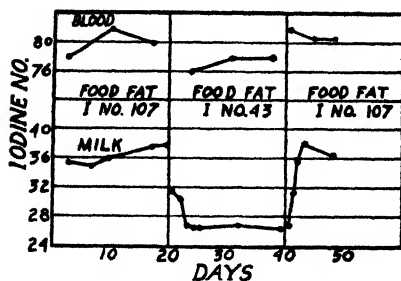


CHART 1. Iodine numbers of plasma total lipids and of milk fat. Cow C.

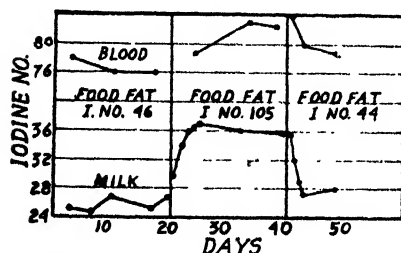


CHART 2. Iodine numbers of plasma total lipids and of blood fat. Cow E.

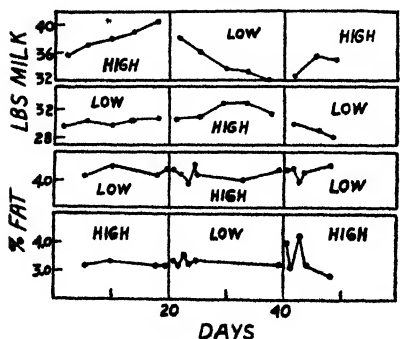


CHART 3. Milk yields and fat percentages, Cows C and E. (High and low refer to the iodine numbers of the fat intake.)

rapidity of the change in the character of the milk fat following a change in the food fat. The last determination for a given period was made on a sample composited from the milking at 4 p. m. and the milking at 4 a. m. At the following noon feeding the cow received her first intake of the changed ration and the first determination thereafter was made on the composite of the milk obtained that evening and the following morning. Thus the production on which the first determination was made following a change in

ration represented milk secreted during 8 hours on the previous ration and during 16 hours on the new.

The data for cow C in chart 1 show that the iodine number dropped from a value of 38 prior to the change to a value of 32 for the first determination thereafter. Further marked drops are revealed in the following two 24 hour composites to a level which remained practically constant for the remainder of the period. When this cow was changed back to the ration of high iodine number, no marked change in the fat secreted was noted at the first, determination, but succeeding 24 hour composites revealed rapid rises to a maximum level on the fourth day after the change. The curve in chart 2 for cow E, which was fed the two rations in reverse order, shows a similar picture. A marked rise is noted immediately after the change to the ration of high iodine number and in the two succeeding determinations, with little change after the third day. Restoration of the original ration was followed by a rapid drop to a minimum value on the fourth day.

It is well understood from many experiments that milk fat can be qualitatively modified by the food fat, but the rapidity of the changes here obtained and the short time required for their completion are especially noteworthy, in view of the time required for food to pass through the digestive tract of the ruminant and in view of current ideas as to the intermediary metabolism of fat prior to its deposition or secretion. Upon feeding butter to a cow which had received no food other than a little hay during the previous 24 hours Gage and Fish (2) found no change in the chylomicron curve up to the fifth hour. Peaks in the absorption curve were found at the sixth hour and intermittently thereafter up to the nineteenth. There were intervening periods in which little or no absorption was indicated. It may be presumed that the absorption of fat ingested in a mixed ration of natural feeds, as used in the present experiment, would be slower than of butter. Moore and Winter (3) have reported that the inert material, iron oxide, commenced to appear in the feces of the cow only after 10 hours, that the high point of excretion was reached after 33 hours and that as long a time as 156 hours elapsed before all the material was excreted.

It is clear that it may be a matter of several hours before the absorption of ingested fat begins in the ruminant, and that it is a gradual and intermittent process which requires an extended period for its completion. Once the fat is absorbed its metabolism involves various intermediary changes in which several organs, notably the liver, have been ascribed a role. While many later experiments throw doubt on the theory of Soxlet that the food source of milk fat is first deposited in the fat depots, as the sole explanation of the course of fat metabolism in lactation, there is ample evidence that the depots do play a role. The recent work of Peterson, Palmer and Eckles (4) suggests that the blood precursor of milk fat is first transformed into a glandular fat intermediate in character between body fat and the fat of milk.

Finally it must be recognized that the modification of the secreted fat under the influence of the diet occurs in opposition to the normal tendency of the gland to secrete a product of constant composition.

The rapidity with which this modification was found to occur in the present studies indicates that the course of metabolism through which the absorbed fat passes after absorption must be short or that the various processes must take place with great speed. Both the magnitude and rapidity of the changes in the character of the milk fat furnish evidence opposed to the widely quoted conclusion of Gage and Fish (2), based on their studies with stained fats, that in the cow milk is derived only to a small degree from the fat in the food.

In view of the changes of the milk fat under the influence of the food, one would expect similar changes in the blood and the data given in the charts for the iodine numbers of the total lipids of the blood plasma indicate this to be true. The determinations are too few to show the exact course of the change in the blood following a change in the diet, but the results do indicate an interrelationship between the degree of saturation of the blood lipids, and that of the food fat on the one hand and that of the milk fat on the other. The extent of the change in the blood, however, is smaller than in the food or milk. Because of the large volume of blood and its rapid circulation, small changes in it might well be reflected in large changes in the milk. Further it must be borne in mind that the blood values represent the changes in the total lipids and that changes of larger magnitude might have been found in the particular fractions which are the actual precursors of milk fat.

Similar changes in the degree of saturation of the blood lipids were observed in our studies (5) of the effect of the ingestion of cod liver oil on the composition of blood and milk. The feeding of this highly unsaturated oil, which caused a rise of approximately 30 per cent in the iodine number of the milk fat, was accompanied by a 10 to 20 per cent rise in this value for the blood lipids. We have also made similar observations on goats (unpublished).

The data for total lipids, lipid phosphorus and cholesterol showed no marked nor consistent changes in the amounts of these lipids in the blood plasma under the influence of the changes in the character of the fat fed. These data, coupled with the fact that the fat intakes were nearly alike in the different periods, indicate that neither the level of fat fed nor the level of any lipid in the blood was a factor in the changes in the character of the fat secreted.

The data for milk yield and fat percentage are presented in chart 3. In general the trend of milk yield is upward with the ration containing the fat of high iodine number and downward in the case of the other ration. Such an observation with only two animals and over brief periods can have no significance other than to suggest a question which may deserve further

study. The curves for fat percentage show little change other than daily fluctuations following the changes of ration. There is no evidence that the change in the character of the food and blood fat had any influence on the percentage of fat in the milk, although it did markedly change its character. This observation is of interest in comparison with the data obtained with the cod liver oil (5), suggesting that the effect of the oil in lowering fat percentage cannot be due to its high degree of unsaturation.

SUMMARY

The course of the changes in the iodine numbers of the blood lipids and milk fat was followed with cows fed in alternate periods rations containing fats of a high and low degree of unsaturation. In half of the cases a marked change in the iodine number of the milk was noted in a composite of the milk secreted during the first 18 hours following a change in ration, and in all cases within the next 24 hours, the maximum change being attained within three or four days. Corresponding but less marked changes were found in the blood. The data reveal a close relationship between food fat and milk fat, and indicate that the course of fat metabolism in lactation must be a very direct one or that the various processes must take place very rapidly.

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THE AGE THICKENING OF SWEETENED CONDENSED MILK

III. EFFECT OF REACTION AND CHANGES IN THE ELECTRICAL CONDUCTIVITY DURING MANUFACTURE AND AGING*

V. C. STEBNITZ AND H. H. SOMMER

Department of Dairy Industry, University of Wisconsin

In a sensitive colloidal system such as milk small changes in the various ionic concentrations are likely to exert a great influence on the stability of the system. Since the electrical conductivity of milk depends upon the various ions present and the hindering effect of the non-electrolytes, it is reasonable to expect that any changes occurring in the ionic equilibrium and the concentration of the non-electrolytes during the manufacture and aging of sweetened condensed milk would be reflected in a change in the electrical conductivity. It is a matter of common experience that an increase in acidity almost invariably decreases the heat stability of milk. With these facts in mind, electrical conductivity and hydrogen-ion concentration measurements were made during the preparation and aging of several batches of sweetened condensed milk. The different batches varied in their stability toward age thickening.

EXPERIMENTAL METHODS

The pH measurements in these trials were made at 25° C. (77° F.) with the quinhydrone electrode and a saturated calomel half-cell.



FIG. 1. SPECIAL ELECTRODE USED IN MEASURING THE ELECTRICAL CONDUCTIVITY OF SWEETENED CONDENSED MILK.

Conductivity measurements were made according to the Kohlrausch method using a Leeds and Northrup microphone hummer, a Leeds and Northrup precision Wheatstone bridge and tunable telephone receivers. A special type of electrode was used so that it could be inserted into the tube of condensed milk when making a measurement without it being necessary

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TABLE 1
Changes in reaction and electrical conductivity during the manufacture and aging of sweetened condensed milk

BATCH	I			II			III			IV			V		
	Con.* × 10 ⁴	pH	Vis.**	Con.* × 10 ⁴	pH	Vis.**	Con.* × 10 ⁴	pH	Vis.**	Con.* × 10 ⁴	pH	Vis.**	Con.* × 10 ⁴	pH	Vis.**
Raw Milk	61.3	6.63		69.8	6.27		61.3	6.62		69.8	6.67		69.8	6.33	
Milk plus Sugar	34.9	6.55		40.5	6.54		40.5	6.57		34.5	6.60		44.2	6.28	
After Forewarming	7.42	6.49		40.5	6.26		37.3	6.57		44.2	6.47		48.69	6.20	
After Condensing			7.4	8.46	5.87	19.8	5.1	6.14	8.7	6.53	6.14	6.2	8.46	5.85	7.4
Storage															
1 Day	6.60	5.62	112.2	7.31	5.98	416.6	4.5	6.13	36.2	5.27	6.00	14.8	7.70	5.77	18.6
2 Days							4.7	6.16	273.1						
4 "			792.2	6.75	5.98	**									
6 "															
7 "															
8 "															
9 "				7.19	6.14		4.9	6.27	740.1	4.97	6.34	69.3	6.47	6.03	568.0
10 "			568.0												
11 "															
12 "							4.47	6.27	1190.0						
14 "							5.03	6.00	773.0						
15 "				6.85	6.18										
16 "	6.17	6.31	525.7												
17 "															
18 "															
19 "															
20 "	6.43	6.33	1088.0							6.80	6.22	28.4		5.90	660.0
22 "															
26 "	6.43	6.30	810.0												
27 "							4.28	6.25	1900.0						
30 "															
96 "															
101 "							4.79	6.18		5.47	5.91	1116.0	7.84	5.95	
106 "															

* Conductivity.

** Solid.

" Viscosity.

‡ Too viscous.

Forewarming temperature, 88° C. (190.4° F.) for 10 minutes.

Storage temperature, 37° C. (98.6° F.)

TABLE 1—(Continued)
Changes in reaction and electrical conductivity during the manufacture and aging of sweetened condensed milk

BATCH	VI			VII			VIII			COW 72			COW 71		
	Con.* × 10 ⁴	pH	Vis.⁹	Con.* × 10 ⁴	pH	Vis.⁹	Con.* × 10 ⁴	pH	Vis.⁹	Con.* × 10 ⁴	pH	Vis.⁹	Con.* × 10 ⁴	pH	Vis.⁹
Raw Milk	72.1	6.58		67.2	6.45		66.7	6.42		63.8	6.64		72.7	6.52	
Milk plus Sugar										41.8	6.59		48.3	6.42	
After Forewarming	40.2	6.53		46.8	6.40		37.8	6.38		40.7	6.48		48.3	6.27	
After Condensing	6.69	6.01	22.3	5.02	5.86	38.4	5.87	5.97	44.6	4.53	6.08	643.0	9.74	5.77	9.9
Storage															
1 Day				4.76	5.87	h									
2 Days							5.29	1850.0		4.52	6.05	h	6.38	5.76	311.8
4 "															
5 "	6.20	6.05	h				5.21	5.91	h	5.20	6.12		6.97	5.78	h
6 "				4.45	5.91										
7 "															
8 "	6.57	5.87								6.37	6.15	**			
9 "															
10 "															
11 "	6.60	5.60													
12 "															
14 "							5.48	6.07							
15 "															
16 "															
17 "															
18 "															
19 "	6.74	6.06		4.96	6.09										
20 "															
22 "															
26 "															
27 "															
30 "															
96 "													6.10	5.88	
101 "	6.58	6.21								4.48	6.15				
106 "															

* Conductivity.

** Solid.

⁹ Viscosity.

h Too viscous.

Forewarming temperature, 88° C. (190.4° F.), for 10 minutes.
 Storage temperature, 37° C. (98.6° F.).

to remove the milk from the tube in which it was stored. This electrode is shown in figure 1. Conductivity measurements were made at 37° C. (98.6° F.), the temperature of storage, using a constant temperature water bath to hold the tubes while the measurements were being made.

The method of making the condensed milk and measuring the viscosity has been described in a previous paper (1).

CHANGES IN REACTION AND ELECTRICAL CONDUCTIVITY DURING THE MANUFACTURE AND AGING OF SWEETENED CONDENSED MILK

Roadhouse and Koestler (2) found the electrical conductivity of the milk from three different cows to be 41.79×10^{-4} , 39.37×10^{-4} and 44.09×10^{-4} mhos. Palmer and Dahle (3) report the average specific conductivity of four determinations for fresh, pasteurized milk as 54.7×10^{-4} mhos at 25° C. Jackson, McNab and Rothers (4) found that the electrical conductivity of bulk milk at Melbourne, Australia, during the months of November, December, February and March varied between 54.9×10^{-4} and 58.7×10^{-4} mhos. These latter investigators also found that the rapid decreases in conductivity as sweetened condensed milk was concentrated could be used as a test for determining the end of the condensing period.

The electrical conductivity and pH during the preparation and aging of 10 batches of sweetened condensed milk is shown in table 1. Eight of these trials were made on mixed milk obtained from the raw milk holding vat of the University Creamery, while two were from individual cows as designated in the table.

ELECTRICAL CONDUCTIVITY

The fresh milk used in these experiments varied in electrical conductivity from 61.3×10^{-4} to 72.7×10^{-4} mhos. However, it is to be remembered that these readings were made at 37° C., which accounts for the values being higher than those previously reported. There appears to be no correlation between the electrical conductivity of the fresh milk and the stability of that milk toward age thickening when made into sweetened condensed milk. Neither is there any correlation between the electrical conductivity during aging and the thickening of the milk. The average conductivities of these 10 trials are plotted in figure 2. The addition of sucrose equivalent to 18.75 per cent of the raw milk caused an average decrease in conductivity from 67.48×10^{-4} to 40.7×10^{-4} mhos. After forewarming at 88° C. (190.4° F.) for 10 minutes there was a slight decrease in conductivity, followed by a great decrease during the condensing. The average conductivity of all ten samples of milk when the condensing was complete was 6.78×10^{-4} mhos. These changes in conductivity are comparable to the results obtained by Jackson, McNab and Rothers (4).

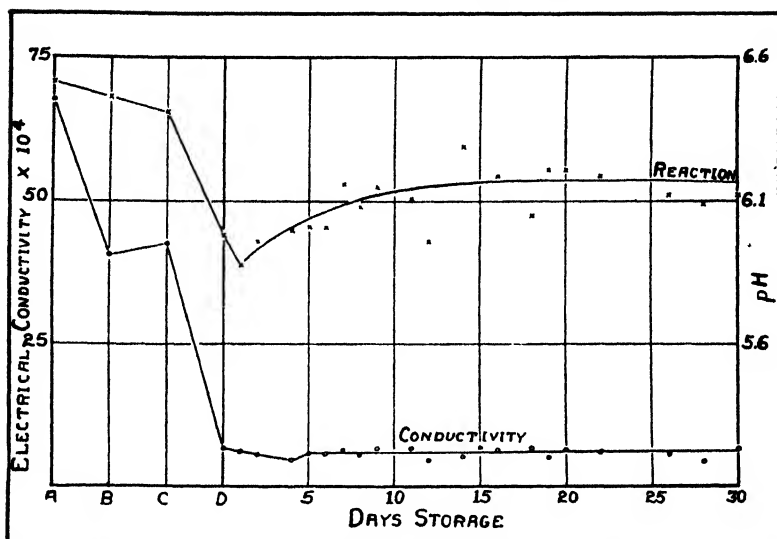


FIG. 2. ELECTRICAL CONDUCTIVITY AND pH DURING THE MANUFACTURE AND AGING OF SWEETENED CONDENSED MILK.

A—raw milk.

C—after forewarming at 88° C. (190.4° F.) for 10 minutes.

B—raw milk plus sucrose.

D—after condensing.

During the first few days of aging there is a slight decrease in conductivity. In every case where the sample was tested at the end of one day this decrease was apparent. After this initial decrease the value rises slightly and appears to remain constant during the aging period. Samples held for over 100 days at 37° C. (98.6° F.) showed no significant change in conductivity.

HYDROGEN-ION CONCENTRATION

The magnitude of the changes in reaction during the manufacture and aging of the milk as shown in table 1 appears to be about the same regardless of the tendency of the milk to thicken or the original acidity of the fresh milk. However, where the pH of the milk was low, as for example in sample II, the milk thickened very rapidly, while other batches condensed during that time of the year but with a higher pH were much more stable. Nevertheless, if the milk is originally unstable, the fact that the pH is normal for fresh milk does not mean that the milk will not thicken rapidly. In other words, the original stability of the milk must be considered in conjunction with the effect of reaction.

The average changes in reaction calculated from table 1 are plotted in figure 2. The average values for the reaction during aging were obtained by determining the increase or decrease in pH at the time of measurement

from what the value was immediately after condensing. If the pH measurements of all samples had been made at the same intervals of time during the aging the average values would have been more satisfactory than it is where, in some instances, only one or two samples were tested.

The reaction of the raw milk used varied from pII 6.27 to 6.67. The addition of 18.75 per cent sucrose caused an average decrease in the pH of 0.05; a further decrease of 0.05 pH was obtained by forewarming to 88° C. (190.4° F.) for 10 minutes. At the end of the condensing period the pH had dropped considerably, as an average, from pII 6.51 to pII 5.98. For a short time during storage at 37° C (98.6° F.) one or two days in most trials, there was a further slight decrease in pII and then a gradual rise of about 0.2 pH after which the reaction remained fairly constant during the aging. Samples held for longer than 100 days at this high temperature showed no appreciable change in reaction.

EFFECT OF CHANGING THE REACTION OF THE FRESH MILK ON THE
SUBSEQUENT THICKENING OF THE CONDENSED MILK

In the previous trial it was noted that samples of raw milk with a low pH exhibited a greater tendency toward age thickening. In this trial lactic acid and sodium hydroxide were used to adjust the reaction of the fresh milk so that there would be a difference in pII of about 0.1 between batches. This trial was made during the month of May, 1933, when the milk was originally unstable and a forewarming temperature of 88° C. (190.4° F.) for 10 minutes was used. The results of this trial are shown in table 2.

TABLE 2
Effect of reaction on the age thickening of unstable milk

TITRATABLE ACIDITY	0.12%	CONTROL 0.15%	0.155%	0.16%
pH of the Original Milk	6.86	6.72	6.60	6.50
<i>Days</i>	<i>Viscosity in Poises</i>			
0	4.9	4.9	4.9	4.9
2	8.6	137.6	312.5	*
4	13.6	1300.0	*	
7	17.3**	*		
9	30.7			
14	95.9			
18	359.5			
24	2812.0			

* Too viscous to measure.

** Visible fat separation.

Lactic acid and sodium hydroxide used to adjust reaction.

Forewarming temperature 190.4° F. for 10 minutes.

These results with unstable milk show conclusively that a decrease in the p_H causes the milk to thicken very rapidly during storage, while increasing the p_H makes the milk more stable toward age thickening.

Changing the reaction of stable milk has less influence on age thickening than changing the reaction of unstable milk. However, the trend of the influence is the same for both types. The results of a trial on stable milk during March, 1934, are shown in table 3.

TABLE 3
Effect of reaction on the age thickening of stable milk

pH OF ORIGINAL MILK	6.86	CONTROL 6.63	6.47	6.32
<i>Days</i>	<i>Viscosity in Poises</i>			
0	6.2	6.2	6.2	6.2
3	7.4	22.9	539.8	*
7	9.9**	30.6	407.6	
10	13.6	33.5	309.1	
14	16.1	30.6	273.1	
18	25.8	30.6	525.7	

Lactic acid and sodium hydroxide used to adjust reaction.

* Too viscous to measure.

** Visible fat separation.

Sucrose, 44.1%; fat, 7.75%; milk solids-not-fat, 19.87%.

Forewarming temperature 190.4° F. for 10 minutes.

In the trials shown in tables 2 and 3 the p_H of the milk was increased by the addition of sodium hydroxide. The data in table 4 were obtained by dividing 32 pounds of raw milk into four 8-pound batches. The first served as a control; to the second was added 1 gram of sodium bicarbonate; to the

TABLE 4
Effect of reaction on the age thickening of unstable milk

TO 8 LBS. MILK	CONTROL	1 GRAM NaHCO ₃	1 GRAM Ca(OH) ₂	1½ GRAMS CA LACTATE
pH after Forewarming	6.29	6.48	6.62	6.31
<i>Days</i>	<i>Viscosity in Poises</i>			
0	18.6	6.2	6.2	21.5
1	584.0	11.6	11.6	2230.0
2	2205.0	14.8	16.7	*
4	*	19.4**	22.3**	
6		25.8	22.3	
12		39.0	16.75	
19		163.2	25.8	

* Too viscous to measure.

** Visible fat separation.

Forewarming temperature 190.4° F. for 10 minutes.

third, 1 gram of calcium hydroxide, and to the fourth, $1\frac{1}{2}$ grams of calcium lactate. In this trial the pH was determined after the sugar had been added and the milk forewarmed. This accounts for the lower readings than in the two previous experiments shown in tables 2 and 3. The condensed milk made from the batches containing the sodium bicarbonate and the calcium hydroxide were so thin that there was visible fat separation in both after 4 days of storage. From these results it seems to appear that the reaction is the governing factor and that whether the alkali contains sodium or calcium is immaterial.

Tables 5 and 6 show the effect of adding various amounts of sodium bicarbonate to two unstable milks which differed in their rates of thickening. It may be seen that small additions have a very marked effect; a change in the pH of only 0.1 produced very noticeable stabilizing effects. There is

TABLE 5
Effect of various amounts of sodium bicarbonate on unstable milk

TO 8 LBS. MILK	CONTROL	$\frac{1}{2}$ GRAM NaHCO ₃	$\frac{1}{2}$ GRAM NaHCO ₃	1 GRAM NaHCO ₃
pH after Condensing	6.01	6.012	6.05	6.18
<i>Days</i>	<i>Viscosity in Poises</i>			
0	22.3	21.5	21.5	16.28
5	*	865.0	501.0	25.8
8	.	*	*	64.4
11				138.8
18				668.0
30				*

* Too viscous to measure.

Forewarming temperature 190.4° F. for 10 minutes.

TABLE 6
Effect of various amounts of sodium bicarbonate on unstable milk

TO 8 LBS. MILK	CONTROL	$\frac{1}{2}$ GRAM NaHCO ₃	$\frac{1}{2}$ GRAM NaHCO ₃	1 GRAM NaHCO ₃
pH after Forewarming	6.43	6.46	6.48	6.54
<i>Days</i>	<i>Viscosity in Poises</i>			
0	7.4	6.2	4.94	4.94
2	125.0	28.4	19.42	7.4
5	668.0	184.0	125.0	11.14**
8	1190.0	422.0	347.2	19.42
12	2060.0	773.0	549.0	50.1
17	*	1933.0	1362.0	173.5

Sucrose, 44.1%; fat, 7.81%; milk solids-not-fat, 19.4%.

* Too viscous to measure.

** Visible fat separation.

Forewarming temperature 190.4° F. for 10 minutes.

danger in adding too much sodium bicarbonate in that the milk will be so thin that the fat will separate during storage. An addition of 60–125 grams (approximately 2–4 oz.) per 1,000 pounds of raw milk is sufficient to stabilize unstable milk toward age thickening. The hydrogen-ion concentration measurements in table 5 were made on the finished product while those shown in table 6 were made after forewarming but before condensing.

The addition of sodium bicarbonate before forewarming was found to be more effective in preventing age thickening than adding it to the finished product as shown in table 7.

TABLE 7
Effect of adding sodium bicarbonate to unstable milk after condensing

TO 8 LBS. MILK	CONTROL	A	B
pH after Forewarming	6.62	6.94	
<i>Days</i>	<i>Viscosity in Poises</i>		
0	14.8	7.4	7.4
3	*	13.6	19.8
5		11.55	64.4
17		16.75	766.0

A 3 grams of sodium bicarbonate added to the milk before forewarming.

B 3 grams of sodium bicarbonate added to the finished product.

* Too viscous to measure.

Forewarming temperature 190.4° F. for 10 minutes.

EFFECT OF FOREWARMING TEMPERATURE ON THE CHANGE IN REACTION

Samples from the same batch of raw milk were forewarmed with sucrose for 10 minutes at the temperature designated in table 8. As the temperature

TABLE 8
Effect of forewarming temperature on reaction

TEMPERATURE OF FOREWARMING	131° F.	180° F.	203° F.	241° F.
	<i>pH</i>	<i>pH</i>	<i>pH</i>	<i>pH</i>
Fresh Milk	6.60	6.60	6.60	6.60
Milk and Sugar	6.55	6.55	6.55	6.55
After Forewarming	6.55	6.53	6.48	6.45

of forewarming increased the pH was lowered, but these changes cannot be correlated with the great difference in stability caused by various forewarming temperatures as shown in the previous paper (5).

DISCUSSION

This work has definitely shown that small changes in the reaction of the raw milk exert a marked effect on the subsequent thickening of the condensed milk. Decreasing the pH causes a more rapid thickening, while increasing the pH decreases the tendency to thicken. The magnitude of

the effect due to the reaction seems to depend upon the original stability of the milk as well as other factors which affect the rate at which the milk will thicken. The conclusion of Rogers, Deysher and Evans (6) that changes in the reaction within reasonable limits have no significant effect upon the subsequent thickening was based upon a trial with very stable milk. With a forewarming temperature of 63° C. (145.4° F.) their control batch showed practically no increase in viscosity when stored at 30° C. (86° F.) for 30 days. Had their forewarming conditions been more favorable for the rapid thickening of the milk their results would, no doubt, have shown that reaction is an important factor.

It was found that for a short time after condensing, one or two days in most instances, there was an average decrease in pH and then a gradual rise of about 0.2 pH, after which the reaction remained fairly uniform during the aging period. This same general trend holds in the case of electrical conductivity. For a few days after condensing there was a gradual drop in electrical conductivity and then a slight rise, after which the value remained constant during the aging period.

From these results it appears that a storage period of several days at 37° C. (98.6° F.) is required for ionic equilibrium to be reached and that after it has been reached it remains unchanged during the aging. This shift in equilibrium appears to occur independently of the tendency of the milk to age thicken. However, instances have been observed where samples thickened very rapidly at first and then for a period showed a progressive decrease in viscosity upon further aging.

CONCLUSIONS

Increasing the acidity of the raw milk causes the sweetened condensed milk to thicken more rapidly during storage, while decreasing the acidity makes a more stable product. With unstable milk a change of 0.1 in the pH exerts a marked effect while with stable milk the effect is not so great.

During the storage of sweetened condensed milk at 37° C. (98.6° F.) there is at first a slight decrease in pH and then a gradual rise of about 0.2 pH after which the reaction remains fairly constant during the aging period regardless of whether the milk thickens slowly or rapidly.

During the spring of the year the unstable milk may be stabilized by adding 60-125 grams (approximately 2-4 oz.) of sodium bicarbonate per 1000 pounds of raw milk. The sodium bicarbonate is more effective when added to the raw milk than when added to the finished product.

The increase in acidity due to forewarming cannot be considered an important factor.

Changes in electrical conductivity cannot be correlated with the stability of the milk toward age thickening.

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IRRADIATED EVAPORATED MILK: THE TRANSMISSION AND ANTIRACHITIC ACTIVATION OF EVAPORATED MILK FILMS BY ULTRA-VIOLET RADIATIONS

G. C. SUPPLEE, R. C. BENDER AND G. E. FLANIGAN

The Dry Milk Company, Inc., Research Laboratories, Bainbridge, New York

AND

M. J. DORCAS AND C. E. GREIDER

National Carbon Company, Inc., Cleveland, Ohio

Numerous data (1-5) have shown the interrelationship between the antirachitic potency of irradiated milk and such factors as the intensity of the incident radiation, time of exposure and character of the milk film. These data have been concerned with natural fluid milk. No data have been available showing analogous interrelationships applicable to evaporated milk. The direct irradiation of evaporated milk presents certain conditions which preclude the assumption that the same or equivalent results will be obtained from the same treatment as applied to fluid milk. It has been shown that ultra-violet radiations within the antirachitic range are absorbed to a large extent by a fluid milk film 0.02 mm. thick; also, various constituents of milk absorb ultra-violet rays to a substantial degree, even in very low concentration (1). In the study of conditions required for efficient and effective activation of fluid milk, it was determined, that notwithstanding the low penetrating power of the antirachitic rays fluid milk could be activated to a substantial degree by appropriate correlation of intensity of the radiations and the character of the milk film as affected by film capacity, thickness, and speed of travel (3) (4).

The irradiation of evaporated milk as such, with its inherent solids content, wide range of viscosity at variable temperatures, homogenization and pre-heating temperatures, all of which are known to alter its physical properties, obviously, will not permit the direct application of the data from correlated studies with fluid milk. In the absence of specific information applicable to evaporated milk, studies similar to those previously carried out with fluid milk were undertaken, employing similar methods, and taking into consideration the inherent physical differences between the two products.

These experiments were designed to determine the following: the difference in degree of activation imparted to milk irradiated in fluid form and that irradiated after evaporation; the effect of irradiating evaporated milk before and after homogenization; the effect of irradiating at different film thicknesses; the effect of irradiating evaporated milk reconstituted to the same solids content as the original fluid milk; to determine the ultra-violet ray transmitting properties of evaporated milk as compared with those of

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fluid milk and as influenced by temperature, homogenization, and the pre-heating of fluid milk. A further objective of the experiments was to determine the degree of activation imparted to evaporated milk by three types of commercial equipment operated under known conditions and to compare the results with those obtained from the same equipment irradiating fluid milk.

EXPERIMENTAL

The experimental plan involved the use of evaporated milk as prepared and normally handled under routine conditions of production. A fully equipped evaporating plant was selected within a short distance from the Research Laboratories, thus permitting quick transportation of the unsterilized products to the laboratory where precision irradiation experiments, spectroradiometric data and other determinations could be made. The facilities also permitted a direct comparison of results obtained from the controlled studies in the laboratory with those obtained in the factory from the different types of commercial equipment. The work was done in the months of November, February and March. The several hundred different samples obtained during the study were canned in the regulation 14½ ounce can and subjected to the usual sterilizing process before running the bio-assays. In order to eliminate uncontrollable variations insofar as practicable, nearly all tests were repeated three times with three different days' production.

The methods previously employed (1) for the study of the transmitting properties and activation of fluid milk films were used for the laboratory irradiation and spectroradiometric studies. The transmitting properties of the milk films were determined with the spectroradiometer mounted as described in a previous report (1). The carbon arc lamp burning "C" type electrodes at 50 volts and 60 amperes was mounted 43 cm. from the flowing film which for these experiments was maintained at a width of 10 cm. Uniformity of film flow rate was maintained by appropriate means for providing constant level of milk in the supply reservoir. Uniform film flow in the various commercial apparatus was maintained with the usual accessories supplied with each type apparatus and further checked by weighing the milk delivered from the apparatus at frequent intervals during treatment. The uniformity and intensity of the radiation emitted by the carbon arcs employed in the commercial apparatus was determined and continually recorded by the Westinghouse ultra-violet ray meter (5); uniform intensity of radiation during the particular test runs was maintained on the basis of the meter record irrespective of the voltage and amperage required to furnish the predetermined intensity of radiation desired. Total solids and fat content were determined on all lots of fluid and evaporated milk required for the experiments.

The bio-assays were made with the sterilized products reconstituted to the same solids content as the original milk. The usual assay procedure was employed wherein the groups of properly prepared rachitic animals receiving the Steenbock rachitogenic diet 2965 (6) were given 4 cc. of the test milk daily for a period of 10 days following a 21 day period on the rickets producing diet unsupplemented. The average degree of calcification from all the animals of the group receiving the same test milk was taken as the criterion of the relative vitamin D potency of the sample.

Record of significant physical and biological data are contained in the accompanying tabulations and graphs. In order to reduce extensive tabular material as much as possible, the average results of complete and independent runs are shown with indication of the maximum variation obtained from the individual experiments.

Table 1 shows comparable data from the irradiation of fluid milk and evaporated milk. In all instances the potency of the product irradiated as fluid milk is higher than that irradiated after evaporation. The magnitude of the greater potency of the fluid irradiated product is dependent upon the intensity of the incident radiation, the time of exposure and thickness of the milk film. Chart I shows the typical ultra-violet transmitting properties of films of fluid, and homogenized evaporated milk of known thickness and comparable film capacity, each determined at a temperature of 85° F. It will be noted that there is a relatively greater penetration of wave lengths below

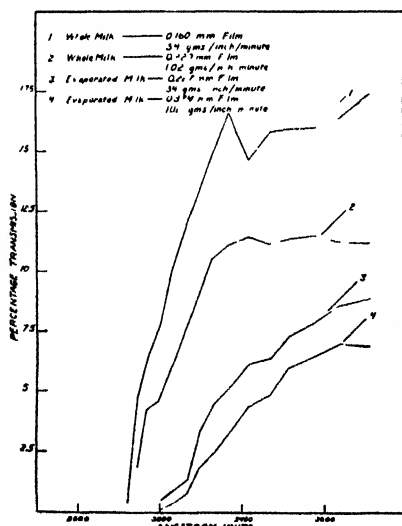


CHART I. Transmission of ultra-violet radiations by films of fluid whole milk and evaporated milk.

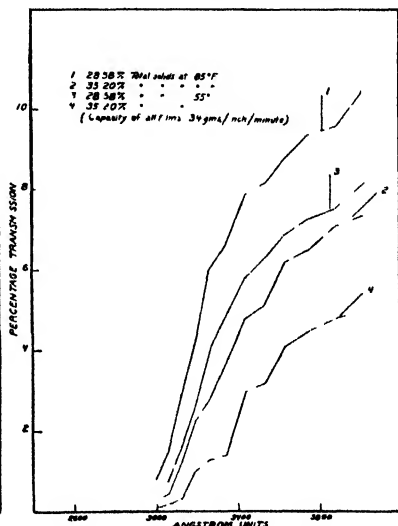


CHART II. Transmission of ultra-violet radiations by films of evaporated milk of different percentage total solids.

TABLE 1
The antirachitic potency of fluid and evaporated milk irradiated under comparable and controlled conditions with laboratory and commercial equipment

("C" carbons used in all cases except with Type V equipment in which "U" were used)

IRRADIATING EQUIPMENT	MATERIAL IRRADIATED	AVERAGE % SOLIDS	AVERAGE RATE PER HOUR	FILM CAPACITY PER INCH PER MIN.	FILM THICKNESS	EXPOSURE PERIOD	ULTRA-VIOLET METER RECORD AT SHORTEST DISTANCE FROM ARC TO MILK	RICKETS HEALING (AVE. LINE TEST)
(1)			(lbs.)	(gms.)	(mm.)	(secs.)	(in.)	(rate per min.)
Laboratory	Fluid Milk	12.08 ± .12		34.02 ± .16	0.14 ± .02	1.9 ± .06	17	13 ± 0.6
"	Evap. Milk, not homo.	28.50 ± .30		34.02 ± .16	0.24 ± .02	4.3 ± .10	17	13 ± 0.6
"	Evap. Milk, homo	28.50 ± .30		34.02 ± .16	0.25 ± .02	4.6 ± .10	17	13 ± 0.6
"	Fluid Milk	12.08 ± .12		102.06 ± .60	0.23 ± .03	1.3 ± .06	17	13 ± 0.6
"	Evap. Milk, not homo.	28.50 ± .30		102.06 ± .60	0.35 ± .08	2.6 ± .03	17	13 ± 0.6
"	Evap. Milk, homo	28.50 ± .30		102.06 ± .60	0.39 ± .06	2.7 ± .07	17	13 ± 0.6
Com 1 Type I	Fluid Milk	11.85 ± .10	2475	222.6 ± 3.7	0.40 ± .04	8.0 ± .80	24	6.6 ± 0.4
"	Evap. Milk, not homo.	28.19 ± .92	2501	223.4 ± 5.2		12*	24	6.5 ± 0.4
"	Evap. Milk, homo.	27.51 ± .40	2527	224.7 ± 4.3		24*	24	6.5 ± 0.4
Com 1 Type II	Fluid Milk	11.93 ± .13	4526	244.0 ± 3.4	0.29 ± .01	2.4 ± .06	22	7.7 ± 0.4
"	Evap. Milk, homo.	30.23 ± .24	4469	241.5 ± 2.2		42*	22	7.7 ± 0.4
Com 1 Type V	Fluid Milk	12.07 ± .00	4008	1018.0	0.17**	0.05*	4.5	(***)
"	Evap. Milk, homo.	27.87 ± .43	4251	1080.0		0.05*	4.5	(***)

(*) Estimated Exposure Period.

(**) Approximate film thickness as stated by manufacturers.

(***) Relative intensity of the radiation transmitted through the milk film showed 2.9 ± 0.15 discharges per minute at a distance of 24 inches from the arc in the case of fluid milk; and 1.42 ± 0.09 per minute at the same distance for evaporated milk.

3000 Å in fluid milk than in the evaporated product. This difference is primarily due to the difference in solids content and film thickness, although data which will be presented later in this report show that the lower transmitting properties of evaporated milk is not due solely to these two conditions.

Variations in the solids content of different lots of evaporated milk may affect the ultra-violet transmitting properties. This is illustrated by the graphs in Chart II. The percentage transmission at 3000 Å for evaporated milks of 28.58 per cent solids and 35.20 per cent solids, each having the same film capacity and determined at 55 and 85 F., is in each case less than 1 per cent, and the variation caused by the difference in solids content is less than $\frac{1}{2}$ per cent. Below 3000 Å the percentage transmission was practically immeasurable with the apparatus used. In order to determine whether the apparent slight difference in transmitting properties within the antirachitic range had a practical bearing on the antirachitic potency, the two evaporated milks were irradiated with the laboratory apparatus under twenty different conditions wherein temperatures, film thickness, and film capacity were the variables and the intensity of the incident radiation constant. The results were not consistent in showing any significant difference in degree of potency attributable to difference in solids content. In four comparable cases there was no difference whatsoever in the potency of the two products; in five cases the higher solids product showed a slightly higher average potency; whereas; in eleven comparable cases the product with lower solids showed a slightly higher potency. The results as a whole cannot be considered as showing any significant difference in potency resulting from irradiating evaporated milk with solids content varying from 28 to 35 per cent.

Since temperature and homogenization are known to affect the viscosity of evaporated milk and consequently film flow characteristics, a series of irradiation experiments and transmission measurements were made with the laboratory apparatus; the factors mentioned being the variables correlated with the antirachitic potency while the incident radiation remained constant. The results are shown in Table 2 and Charts III and IV. An examination of the data shows that there is no consistent and significant difference in the potency of evaporated milk irradiated before or after homogenization; neither is there a consistent or distinctive difference in potency attributable to temperature of irradiation throughout the range from 55 to 165° F. Each of the variable factors concerned in this study contribute to variations in film thickness and period of exposure. The product of the value for film thickness multiplied by the time of exposure is higher for the low film capacity rate at all temperatures except 55 and 165° F., than the product figures for the higher film capacity rate; the potency of the milk irradiated at the lower rate is likewise uniformly and significantly higher than at the higher rate. This distinctive difference in potency is probably the most conclusive and

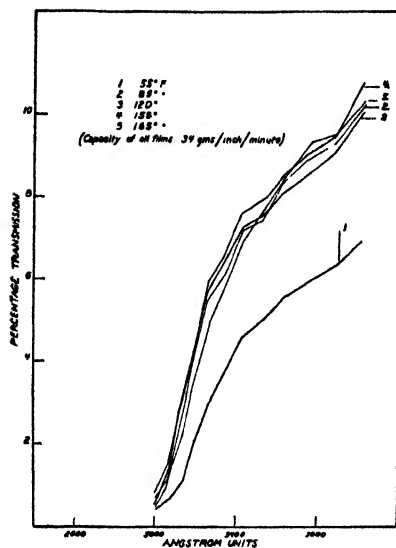


CHART III. Transmission of ultra-violet radiation by films of non-homogenized evaporated milk at different temperatures.

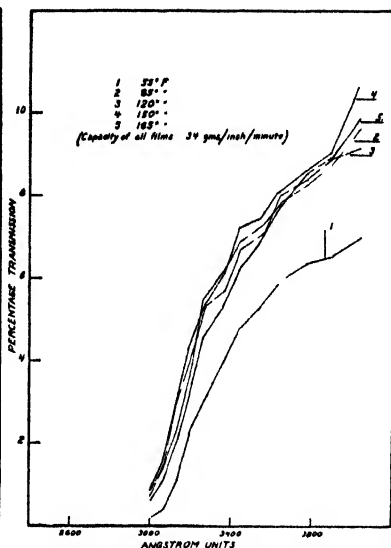


CHART IV. Transmission of ultra-violet radiation by films of homogenized evaporated milk at different temperatures.

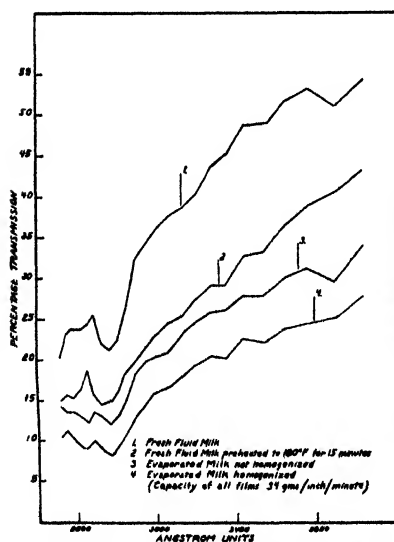


CHART V. Transmission of ultra-violet radiation at 55° F. by films of milk diluted to 3% solids concentration.

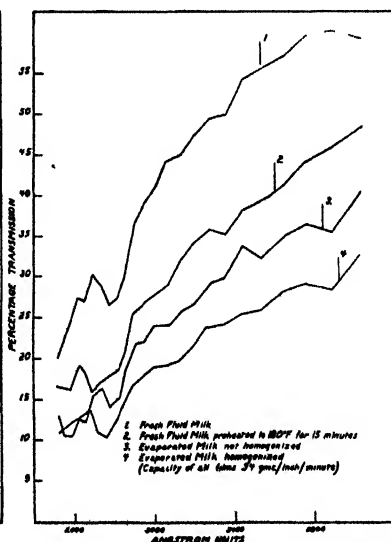


CHART VI. Transmission of ultra-violet radiation at 85° F. by films of milk diluted to 3% solids concentration.

TABLE 2

The antirachitic potency of evaporated milk irradiated as such as affected by temperature and film characteristics
 (Average solids as irradiated $28.78 \pm 0.22\%$; "C," carbon, 17 inches from arc to milk film; vertical distance of film travel, 16 inches; ultra-violet meter rate, 13 ± 0.6 per min.)

MATERIAL IRRADIATED	TEMP.	VISCOSITY (SECS. PER 100 GMS.)	FILM CAPACITY PER IN. PER MIN.	FILM THICKNESS	EXPOSURE PERIOD	RICKETS HEALING (AVE. LINE TEST)
			(gms.)	(mm.)	(secs.)	(+)
Evap. Milk, not homo.	55	43.6	$34.02 \pm .16$	.260	4.47	2.62 ± 0.18
" " homo.	55	46.3	$34.02 \pm .16$	.280	4.85	2.62 ± 0.28
" " not homo.	55	43.6	$102.06 \pm .60$	.468	2.92	1.44 ± 0.16
" " homo. "	55	46.3	$102.06 \pm .60$	.473	2.95	1.45 ± 0.16
Evap. Milk, not homo.	85	34.1	$34.02 \pm .16$	.231	4.32	2.50 ± 0.36
" " homo.	85	34.7	$34.02 \pm .16$	.227	4.63	2.25 ± 0.05
" " not homo.	85	34.1	$102.06 \pm .60$	.353	2.20	1.55 ± 0.35
" " homo.	85	34.7	$102.06 \pm .60$	.374	2.60	1.40 ± 0.40
Evap. Milk, not homo.	120	30.6	$34.02 \pm .16$	.225	4.21	3.06 ± 0.60
" " homo.	120	31.6	$34.02 \pm .16$	.215	4.03	2.37 ± 0.17
" " not homo.	120	30.6	$102.06 \pm .60$	.288	1.80	1.56 ± 0.34
" " homo.	120	31.6	$102.06 \pm .60$	.299	1.87	1.62 ± 0.12
Evap. Milk, not homo.	150	27.0	$34.02 \pm .16$	.196	3.63	2.87 ± 0.23
" " homo.	150	33.6	$34.02 \pm .16$	.195	3.65	2.20 ± 0.30
" " not homo.	150	27.0	$102.06 \pm .60$	.272	1.70	1.50 ± 0.10
" " homo.	150	33.6	$102.06 \pm .60$	.283	1.77	1.62 ± 0.09
Evap. Milk, not homo.	165	29.7	$34.02 \pm .16$	.176	3.30	2.87 ± 0.13
" " homo.	165	40.2	$34.02 \pm .16$	.224	4.20	2.50 ± 0.50
" " not homo.	165	29.7	$102.06 \pm .60$	.304	1.90	1.12 ± 0.02
" " homo.	165	40.2	$102.06 \pm .60$	.307	1.92	1.37 ± 0.17

(*) Saybolt Viscosimeter used.

characteristic evidence shown by the data in Table 2. However, the data as a whole seem to be equally conclusive in showing that the antirachitic response of evaporated milk irradiated as such is not solely determined by the power factor involving intensity of radiation per unit amount of milk and period of exposure. Evidence of similar character from fluid milk has been reported heretofore (3) (7).

The direct relationship between viscosity and film thickness seems to be most significant throughout the temperature range from 55 to 150° F. or thereabouts, and the greatest apparent effect of viscosity on film thickness appears to lie between the temperatures of 55 and 85° F. Similar relationships are also shown by fluid milk as will be noted in Table 3. The transmission of ultra-violet rays through the evaporated milk films at different

TABLE 3
The effect of temperature on the viscosity and film thickness of fluid whole milk

TEMPERATURE	VISCOSITY* (SECS. PER 100 GMS.)	FILM CAPACITY PER IN. PER MIN.	FILM THICKNESS	EXPOSURE PERIOD DURING 10-INCH VERTICAL TRAVEL
		(gms.)	(mm.)	(secs)
55	26.4	34.02	.183	3 43
55	26.4	102.06	.304	1 90
85	23.7	34.02	.164	3 07
85	23.7	102.06	.218	1.36
120	22.9	34.02	.150	2 80
120	22.9	102.06	.179	1.22
150	22.3	34.02	.136	2.55
150	22.3	102.06	.192	1.20
165	23.1	34.02	.139	2.60
165	23.1	102.06	.192	1.20

* Saybolt Viscosimeter used.

temperatures (Charts III and IV) shows clear evidence of a critical temperature between 55 and 85° F. According to these curves the transmission of the shorter ultra-violet rays at about 3000 Å or below does not appear to be substantially different throughout the temperature range of 55 to 165° F. However, there is a marked difference in transmission of the longer ultra-violet at temperatures of 55° F. and 85° F., but practically no difference throughout the range from 85 to 165° F. These results as a whole cannot be entirely explained as due to differences in viscosity and film thickness.

It has been previously shown (8) that milk contains a protein fraction which has a critical agglomeration temperature at about 73° F. The agglomerate manifested above this temperature could be redispersed to a water clear solution simply by lowering the temperature. Agglomeration and redispersion was found to be reversible and a function of temperature providing the colloidal suspension had not been previously heated at too

high a temperature, or held too long at lower temperatures. A water clear suspension of this material in 0.04% concentration absorbed appreciable ultra-violet radiation in the antirachitic range and the absorption was further increased by agglomeration of the molecules. It is suggested that the physical properties of this material are in some manner concerned in determining the character of the milk films involved in the present study. In order to determine if these previous observations are pertinent in the principles and practices prevailing in the commercial irradiation of evaporated milk, the transmitting properties of fluid and evaporated milk as affected by heat treatment and the usual processing steps, were determined.

Since a measurable degree of transmission within the ultra-violet range was desired in order to accentuate differences, all test samples were diluted with water to 3 per cent total solids; the same film capacity of all samples of diluted milk was used for the spectroradiometric measurements. Data were obtained from normal fluid milk not previously heated, the same milk heated to 180° F. and held for 15 minutes, and from parallel samples of homogenized and non-homogenized evaporated milk prior to final sterilization. The results are shown in Charts V and VI from which the following differences are obvious.

The percentage transmission of all wave lengths measured, including those in the antirachitic range is distinctively greater for the fluid milk not previously heated than it is for the pre-heated milk, or the evaporated milk irrespective of the temperature at which the measurements were made. It appears that the progression of steps in the processing of evaporated milk, namely, the initial pre-heating, concentration, and homogenization, each contributed additively to change its physical character in a manner which tends to decrease the ultra-violet transmitting properties. This progressive decrease is especially pronounced in the ultra-violet range above 2950 Å, although the same relative effect is also shown in the antirachitic region below 2950 Å but to a lesser degree.

This type of study involving measurement of milk films of known characteristics may prove to be a useful method for determining the physical character of milk, particularly as affected by physical treatment. The difference in the transmitting properties of the various milk appears to be in harmony with expectations based upon observations from previous study of the colloidal protein constituent of milk already discussed. It would seem quite apparent that the screening effect of agglomerated colloidal matter or increased density of suspended particles would tend to decrease the efficiency of the incident irradiation.

It appears that there are two reasons which account for the difference in potency of fluid milk and evaporated milk irradiated as such. The first, and undoubtedly the most significant, is the greater film thickness of the evaporated product. As shown in the controlled experiments with labora-

tory apparatus, this can be compensated for in part by the exposure of thinner films subjected to the radiations for longer periods of time. The balanced relationship between film capacity, film thickness, time of exposure and appropriate intensity of radiation necessary for the treatment of evaporated milk in order to impart a potency as high as is obtained in fluid milk presents practical operating and engineering problems which are not yet overcome in the available commercial equipment.

The second reason for the lower potency of evaporated milk treated under conditions paralleling those used for fluid milk, is the inherent and accumulative change in the physical character of the product caused by heat, concentration and homogenization. The degree to which these inherent conditions directly affect antirachitic potency, aside from contributing to increased thickness and density of the film, is illustrated by the following: Parallel samples of fluid and evaporated milk, homogenized and non-homogenized, were irradiated with the laboratory apparatus under identical conditions after reconstituting the evaporated product to the same solids content as contained in the normal fluid milk. The average degree of calcification (average line test) from 4 cc. of the irradiated fluid milk was 3.13 +; for the reconstituted non-homogenized evaporated milk, 3.04 +, and for the homogenized product 2.80 +. The average variation between individual samples within each of the specified groups was 0.16 +. These results were obtained under strictly comparable conditions wherein high intensity radiations were employed. The films were substantially 0.10–0.12 mm. thick and the exposure period was approximately 1 second. Under these conditions wherein all factors were synchronized to give a maximum degree of potency in an efficient manner, the difference in the vitamin D content attributable solely to the difference in physical character of the milk constituents is not great, but nevertheless measurably lower from the homogenized evaporated product than from the fluid milk.

Table 4 shows comparable data from an extended series of irradiation experiments with commercial equipment (Type II) wherein factory methods prevailed in the treatment of evaporated milk. The experiments were fully controlled with regard to known and predetermined film capacity and intensity and character of the incident radiation. The data readily reveals that there is a certain degree of correlation between film capacity, or rate of operation in terms of pounds per hour, and the antirachitic potency, and also between intensity of the incident radiation and potency. However, the highest potency obtained at the lowest rate of operation and highest intensity is substantially less than obtained during the irradiation of fluid milk with the equipment operated at similar capacities and with comparable intensity of radiation (Table I). Furthermore, it will be noted that the potency of all samples is substantially less than that obtained in the precision control experiments with laboratory apparatus operated at the lower capacity rate.

TABLE 4

The antirachitic potency of evaporated milk irradiated as such as affected by type of carbon and capacity of operation of commercial irradiating equipment type II

(Average Percent Solids in Evaporated Milk as Irradiated 28.11 ± 0.08 ; temperature during irradiation $135^{\circ} \text{F.} \pm 10^{\circ}$)

SOURCE OF RADIATION	AVE. RATE PER HOUR	FILM CAPACITY PER IN. PER MIN.	EXPOSURE PERIOD	ULTRA-VIOLET METER RECORD AT SHORTEST DISTANCE FROM ARC TO MILK	RICKETS HEALING (AVE. LINE TEST)
"C" carbon	(lbs.) 6200	(gms.) 334.3 ± 3.2	(secs.) 3.8 (*)	(ms.) (rate per min.) 22	(+) 0.97 ± 0.37
"U" carbon	"	"	"	"	1.13 ± 0.07
"C" HI carbon	"	"	"	"	1.10
"Q" carbon	5730	309.9 ± 2.3	4.0 (*)	22	0.90 ± 0.20
"U" carbon	"	"	"	"	1.23 ± 0.27
"Q" carbon	5080	268.0 ± 3.4	4.2 (*)	22	0.93 ± 0.27
"U" carbon	"	"	"	"	1.26 ± 0.26
"Q" carbon	4280	231.0 ± 1.0	5.0 (*)	22	1.17 ± 0.06
"U" carbon	"	"	"	"	1.47 ± 0.07
"Q" carbon	3400	182.6 ± 0.0	5.6 (*)	22	1.36 ± 0.13
"U" carbon	"	"	"	"	1.50 ± 0.10

(*) Estimated Exposure Period.

The data presented in this report were obtained for the purpose of illustrating the concrete effect of various factors and interrelationship of factors which contribute to the degree of antirachitic potency obtained during the irradiation of milk, more particularly, evaporated milk. In comparing the results from the irradiation of evaporated milk as such with those from the irradiation of fluid milk, the same basic relationships are involved. However, the irradiation of evaporated milk presents certain inherent problems accentuated to a greater degree than is applicable in the irradiation of fluid milk. The differences in the inherent character of the two products are such that a lower degree of potency in the evaporated product inevitably results irrespective of the degree of control of factors known to be significant. The operation, design, and engineering features now prevalent in commercial irradiation equipment does not permit as high a degree of antirachitic potency in the evaporated product as it is possible to obtain by the same or equivalent operation during the treatment of fluid milk. If irradiated evaporated milk and irradiated fluid milk are to have the same antirachitic potency as determined by current methods of assay, the only way of accomplishing this result with present equipment is to irradiate the fluid product before concentration, otherwise, the two products, even though both are competently treated, must be classified and recognized as having different assay values.

SUMMARY

1. The irradiation of evaporated milk as such does not result in as high a degree of antirachitic potency as the irradiation of fluid milk when films of the same capacity are subjected to the same intensity and quality of ultra-violet radiation.

2. Films of evaporated milk of the same capacity are thicker and more dense than those of fluid milk with the same capacity. The depth of penetration of the ultra-violet rays, or transmitting properties of evaporated milk films is consequently less than that of fluid milk films.

3. The degree of antirachitic activation imparted to evaporated milk is not significantly different from the homogenized and non-homogenized product; nor is it significantly affected by irradiating at temperatures varying from 55 to 165° F.

4. The ultra-violet transmitting property of milk is progressively decreased by pre-heating to 180° F., by concentration, and by homogenization. This decrease is caused by physical changes in the inherent milk constituents, and is independent of the density and thickness of the milk films.

5. Greater antirachitic potency of evaporated milk irradiated as such may be brought about by exposure of thinner films for longer periods of time, or by increasing the intensity of the incident radiation. The potency obtained by such means is not equal to the potency obtained by the irradiation of fluid milk films treated under comparable conditions.

The authors wish to record appreciation of the cooperation extended by the Creamery Package Manufacturing Company and the Cherry-Burrell Corporation for the loaning of equipment and for providing certain facilities necessary for conducting particular phases of the work reported herein.

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A STUDY OF VARIATIONS IN THE LACTOSE CONTENT OF MILK*

W. R. BROWN¹, W. E. PETERSEN² AND R. A. GORTNER¹

College of Agriculture, University of Minnesota, St. Paul

It seems to have been taken for granted that lactose is the least variable of the major constituents of milk. A review of the literature, however, reveals a lack of experimental data in support of this idea and also a need for more work on this phase before other important experimental work on the secretion of lactose can be launched.

HISTORICAL

That there are marked variations in the lactose content of milk was reported as early as 1891 by Van Slyke (15). Eckles and Shaw (5) among others have furnished abundant evidence in support of this fact. The literature reports on the variations in blood sugar in lactating animals are not so conclusive. Awdejewa and co-workers (2) report marked daily variations in blood sugar, while Richter (10) reports but slight variations. Schuenert and Pelchrigin (12), Hayden and Fisk (6), Moussu and Moussu (9), and Awdejewa and co-workers (2) have been unable to find any marked difference between the blood sugar levels in lactating and non-lactating cows. In marked contrast Widmark and Carlens (16), Auger (1), Schwarg, Mezler, Andelburg (14), Schlothauer (14), Hewitt (7), Hodgson, Riddell and Hughes (8) and Blackwood and Sterling (3) report lower blood sugar for lactating than non-lactating cows.

Attempts to influence the blood sugar level by feeding sugars failed to produce results—Carlens and Krestownokoff (4), Richter (10), Scheicher (11) and Hodgson, Riddell and Hughes (8). The latter, however, report that when 6 to 8 pounds of sugar were introduced into the stomach by means of a stomach tube a marked hyperglucemia resulted.

The Problem

Inasmuch as the literature failed to reveal any definite information as to the relationship of blood sugar and lactose, or to hourly variations of these constituents, a series of experiments was projected to determine whether the daily and hourly variations occurring under normal herd conditions were great enough to modify our experimental results.

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* The data in this paper are taken mainly from a thesis presented by W. R. Brown in partial fulfillment for the Ph.D. degree and published with the approval of the Director as Paper No. 1380.

¹ From the Division of Agricultural Biochemistry, University of Minnesota.

² From the Division of Dairy Husbandry, University of Minnesota.

Experimental

The animals used in all the experimental work were purebreds, and unless otherwise noted were all on the regular herd ration, with water *ad-lib*.

Collection of Samples

The milk samples used in the study of the morning and evening milks were obtained from the bucket immediately after the milker had finished stripping the gland. The samples were collected in half-pint bottles, to which a few drops of chloroform had been added. They were then stored in a refrigerated room at 6° C. until analysed. The period between sampling and preparation for analysis was about twelve hours. The samples used for the study of the hourly variations were obtained by stripping the right half gland at each sampling.

The blood samples were obtained from the jugular vein, using sodium citrate as an anticoagulant. Filtrates were prepared according to the Folin-Wu method.

Analysis of Samples

The lactose determination of the milk was carried out according to the colorimetric picric acid method of Bierman and Doan.⁸ The standard solution was freshly prepared each week and consisted of one per cent pure lactose dissolved in picric acid solution saturated at 20° C.

Duplicate, five cubic centimeter, samples of the blood filtrate were taken for the glucose determinations, which were carried out by the micro method of Shaffer-Hartmann.

Experiment 1

Samples of the morning and evening milk were collected from Jersey cows 143, 160, 163 and 167, and from Guernsey cows 538, 544, 550 and 551 and analysed for lactose. Cows 160, 163, 544, 550 and 551 were used for one day, cows 167 and 538 were used for two days, and cow 143 was used for five days.

Experiment 2

Twelve consecutive hourly samples of milk were collected from Jersey cows 143, 160, 163 and 167, and from Guernsey cows 538, 544, 550 and 551 and analysed for lactose. From cows 160, 163, 167, 538, 550 and 551 simultaneous collections of blood were made and analysed for glucose. In the case of cows 160, 163, 538 and 551, the hourly milk samples were measured, in order that the total lactose secreted might be determined.

⁸ JOURNAL OF DAIRY SCIENCE, p. 381, 1924.

*Results**Experiment 1*

Table 1 shows the variations in lactose between samples of milk obtained from the pail of the milker at the time of the regular morning and evening

TABLE 1
Comparison of the lactose content of morning and evening milk

COW NO	BREED	PERCENT LACTOSE	
		A M MILK	P M MILK
143	Jersey	4.85	4.40
"	"	4.43	4.68
"	"	5.09	5.30
"	"	4.85	4.86
"	"	4.48	4.72
160	"	4.70	4.65
163	"	4.71	3.97
167	"	4.99	4.68
"	"	4.64	4.32
538	Guernsey	5.02	4.75
"	"	5.41	5.47
544	"	4.76	5.23
550	"	4.40	4.36
551	"	5.22	5.07
	Average	4.82	4.75

milking. In all eight cows are included, and, as they were on the regular herd ration, the results recorded are what may be expected to hold for normal cows under general herd conditions.

Experiment 2

Table 2 shows the amount of lactose found in samples of milk collected at hourly intervals, from 6 cows, between the regular morning and evening milkings and for one cow between evening and morning milkings. Table 3 shows the blood sugar found in hourly samples of blood, taken almost simultaneously with the milk samples from 6 of the cows, and Table 4 shows the amount of milk obtained at the hourly milking from 4 of them.

Figures 1, 2, 3 and 4 illustrate graphically the results obtained with cows 160, 153, 538 and 551.

DISCUSSION OF RESULTS

Table 1 shows that if cows are milked at regular intervals, twice daily, the deviations between the sugar content of the morning and evening milk samples are reasonably small. Table 2, on the other hand, indicates that if hourly samples of milk are taken the lactose is subject to wide variation. The blood samples recorded in Table 3, which were collected at the same

TABLE 2
Comparison of the lactose content in hourly samples of milk

COW NO.	BREED	LACTOSE IN MILK													
		Time													
		A. M.							P. M.						
		6:00	7:00	8:00	9:00	10:00	11:00	12:00	1:00	2:00	3:00	4:00	5:00		
160	Jersey	% 4.70	% 4.65	% 4.34	% 5.03	% 5.04	% 4.49	% 4.67	% 4.65	% 4.64	% 4.65	% 4.38	% 4.40		
153	"	4.71	3.03	2.85	3.67	3.92	3.63	4.05	3.59	4.15	4.11	4.04	3.95		
167	"	4.99	4.48	4.27	4.27	4.25	4.17	4.35	4.49	4.65	4.75	4.68	4.68		
538	Guernsey	5.02	4.36	4.67	4.49	4.50	4.88	5.09	5.06	5.29	5.20	5.21	4.75		
550	"	4.40	4.18	4.21	3.95	3.95	3.88	3.95	4.00	4.21	4.38	4.66	4.36		
551	"	5.22	4.83	4.73	5.09	4.68	4.87	5.04	5.42	4.83	5.36	5.20	5.22		
		P. M.							A. M.						
143	Jersey	4.70	4.35	3.65	4.45	4.45	4.40	4.15	4.40	4.35	4.55	-	4.77		

TABLE 3
Comparison of the blood sugar in hourly samples

COW NO.	BREED	GLUCOSE IN BLOOD											
		Time											
		A. M.						P. M.					
		6:00	7:00	8:00	9:00	10:00	11:00	12:00	1:00	2:00	3:00	4:00	5:00
160	Jersey	% .025	% .037	% .035	% .027	% .028	% .028	% .028	% .030	% .028	% .024	% .025	% .020
153	"	.028	.024	.033	.027	.018	.021	.030	.025	.018	.022	.021	.025
167	"	.038	.031	.035	.035	.038	.037	.041	.043	.054	.049	.038	.044
538	Guernsey	.038	.045	.029	.035	.037	.040	.040	.043	.032	.040	.034	.037
550	"	.035	.032	.032	.042	.041	.039	.034	.034	.038	.038	.038	.035
551	"	.037	.038	.033	.037	.028	.040	.029	.034	.023	.027	.025	.020

TABLE 4
Cubic centimeters of milk obtained at hourly milkings

COW NO.	BREED	CC. OF MILK											
		Time											
		A. M.						P. M.					
		6:00	7:00	8:00	9:00	10:00	11:00	12:00	1:00	2:00	3:00	4:00	5:00
160	Jersey	.. ..	26	60	440	410	170	217	189	175	170	183	137
153	"	.. ..	26	27	42	59	137	72	95	145	96	103	142
538	Guernsey	.	120	89	143	30	128	158	172	173	745	475	350
551	"	.	118	59	126	32	35	205	370	1000	625	184	210

COW 160

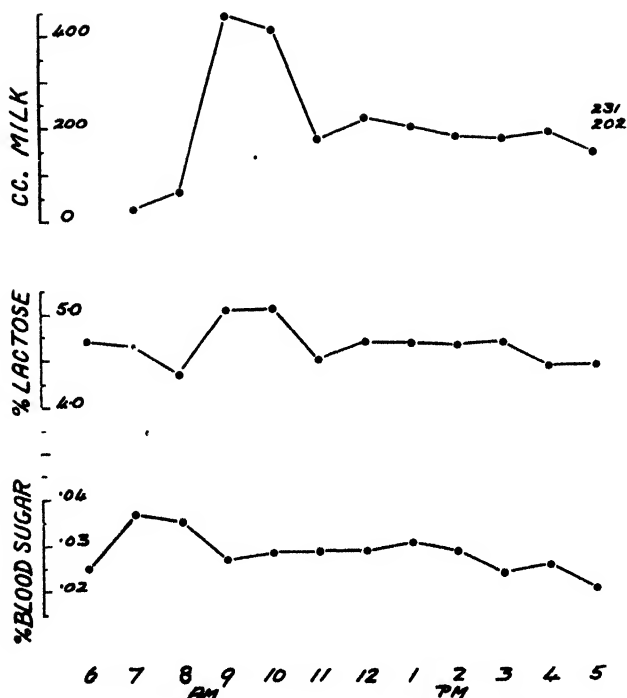


FIG. 1. Hourly fluctuations in blood sugar, CC. milk secreted, and lactose content of milk.

202 cc. hourly milk secreted for above 11-hour period.

231 cc. average hourly milk secreted for 10 days preceding experiment.

time as these hourly milk samples, likewise show marked fluctuations in the percentage of glucose present. The hourly variations found in the blood glucose suggested a reason for the wide lactose variations, so the correlation coefficients of these variables were determined.

The correlations between the milk lactose and the blood glucose, when the samples were collected almost simultaneously, are negative in five out of the six cases. The probabilities of these coefficients arising through random sampling from uncorrelated material are in all six cases too high to permit of the attachment of significance to the correlations. When the same data

COW 163

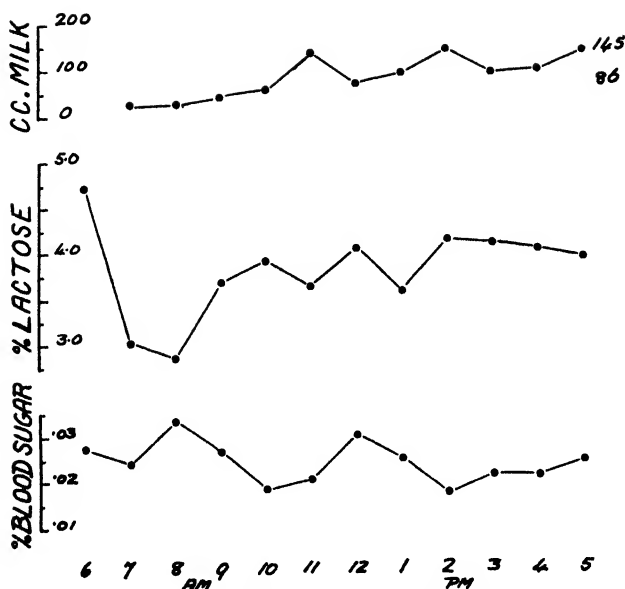


FIG. 2. Hourly fluctuations in blood sugar, CC. milk secreted, and lactose content of milk.

86 cc. hourly milk secreted for above 11-hour period.

145 cc. average hourly milk secreted for 10 days preceding experiment.

were used to correlate the blood sugar with the milk sugar of the collection one hour later, five of the six samples became more positive. However, only one of these is significantly positive, while one other coefficient (Cow 551) is significantly negative. The circumstance that five out of the six correlations became more positive appears of itself to be significant, as such would occur only once in sixty-four trials through random sampling only. This may indicate a tendency towards a definite association of the variables which is obscured by the extremely small size of the samples. These data are recorded in Table 5.

TABLE 5
The correlation between blood sugar and lactose

COW NO.	CORRELATION WHEN SAMPLES ARE COLLECTED ALMOST SIMULTANEOUSLY		CORRELATION WHEN BLOOD SAMPLES WERE COLLECTED ONE HOUR BEFORE MILK SAMPLES	
		P		P
153	- .3256 ± .258	.30	+ .0530 ± .301	.88
160	- .0001 ± .289	1.00	+ .1434 ± .295	.68
167	+ .4111 ± .162	.19	+ .8057 ± .112	.01
538	- .1009 ± .286	.74	+ .3504 ± .234	.29
550	- .1935 ± .187	.55	- .0672 ± .300	.84
551	- .1595 ± .281	.62	- .6921 ± .157	.02

The failure to demonstrate a relationship between the blood and milk sugar is possibly due to several interfering factors, some of which will be considered.

The fairly constant lactose values obtained between twice-daily milk samples, and the wider variations obtained between samples collected at more frequent intervals agree with the results of Eckles and Shaw, but such hourly variations as have been found in the blood sugar have never before been reported.

One possible explanation as to the cause of these blood sugar fluctuations is that in the dairy cow, which is in reality an abnormal but highly specialized organism devoted to the special work of milk production (more than in any other animal), certain of the blood constituents are removed in large quantities by the mammary gland. In the case of the blood sugar it seems possible that it may be continually removed but not replenished from the liver until a certain low level is reached. This would result in a continuous series of waves, of whose duration we are ignorant, and it is possible that our hourly samples have been taken at different points on these waves.

It is thought that the explanation for the greater uniformity of the lactose in the twice-daily milkings is that although the blood sugar continually fluctuates, it probably does so around a slowly changing mean; consequently, while the percentage of lactose secreted by the gland is continually changing, the storing of the milk in the gland over a period of hours, before it is drawn, results in a mixing of all the milk secreted with the production of what is essentially an average or composite sample for the whole intermilking period. If this is actually the case the reason for the variations between the hourly samples becomes more apparent, because if the lactose is secreted against the blood sugar any slight variation in the latter will modify the lactose secreted so that, as the intergland mixing is considerably lessened, the milk obtained reflects the blood sugar variations to a greater extent.

Every milk sample, however, is probably modified by several factors. For instance it has been a common experience to find that the quantity of milk

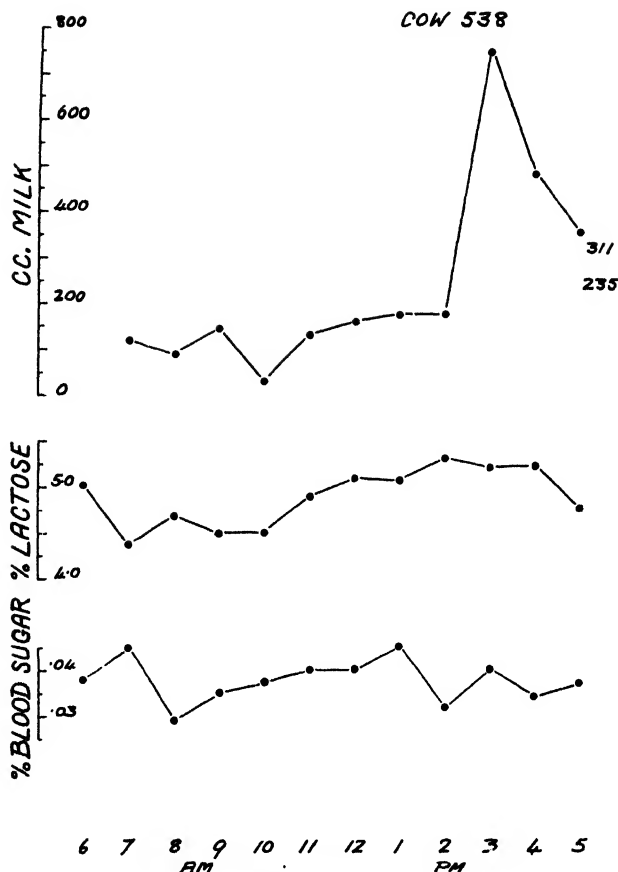


FIG. 3. Hourly fluctuations in blood sugar, CC. milk secreted, and lactose content of milk.

235 cc. hourly milk secreted for above 11-hour period.

311 cc. average hourly milk secreted for 10 days preceding experiment.

obtained at successive hourly milkings varies greatly. If, as is thought by most recent workers, the secretion of milk is a continuous and constant process, these varying quantities of milk can only mean an unequal liberation of milk into the teat ducts, and as much experimental evidence indicates, a storage of milk in the gland even though the latter has been carefully stripped. This stored milk, which may have been secreted against a different blood sugar, later drains into the ducts and mixes with that produced since the last milking. Likewise, some milk produced since the last milking will probably be unavailable at the next stripping. That the amount of milk

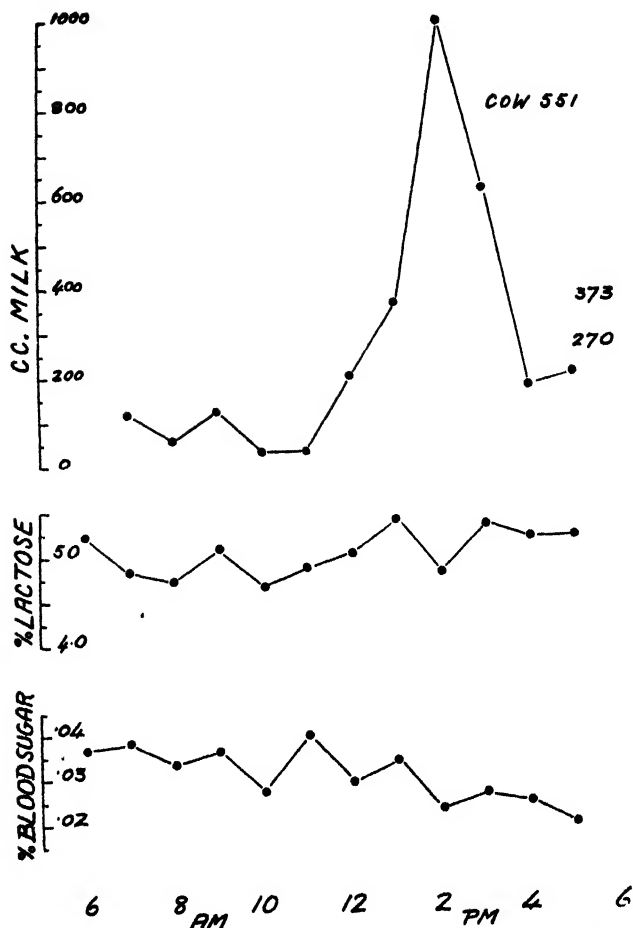


FIG. 4. Hourly fluctuations in blood sugar, CC. milk secreted, and lactose content of milk.

270 cc. hourly milk secreted for above 11-hour period.

373 cc. average hourly milk secreted for 10 days preceding experiment.

remaining after stripping varies in quantity renders the application of a constant correction for this factor impracticable.

CONCLUSIONS

Because of the complications outlined it appears that the satisfactory sampling of milk and blood for comparison studies is one of the most difficult problems confronting the investigator in this field. The results indicate that the old method of taking a blood sample just prior to the usual

milking period, and then the milk sample is not as satisfactory as when the gland is first stripped, a blood sample taken and then the milk sample collected, by stripping the gland one hour later.

It is fully realized that this method does not completely solve the problem of sampling the blood and milk for comparison studies, but it is thought to have a distinct advantage over the older and generally used one.

SUMMARY

1. A similarity was found between the lactose content of the morning and evening milk of individual animals, when the samples were taken at the regular milking periods.

2. The lactose content of the milk showed considerable variation between successive hourly samples.

3. Hourly variations were found in the blood sugar of milking cows.

4. Simultaneously collected samples of blood and milk show little or no positive correlation as to sugar content.

5. In general samples of milk collected one hour later than the blood samples show a greater tendency towards higher correlation in respect to sugar than do simultaneously collected samples.

6. The difficulty of the satisfactory sampling of blood and milk for comparison studies is emphasized, and an improved sampling method suggested.

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American Dairy Science Association Announcements

ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

In 1927 the International Association of Ice Cream Manufacturers and in 1931 the International Association of Milk Dealers began the collection, publication and sale of abstracts of literature of interest to their membership. The abstracts have been published approximately on a yearly basis. There was a need for more rapid publication of abstracts, of extending the scope to include all milk products, and to extend the usefulness of the service by expanding beyond individual associations. The obvious manner for accomplishing these objectives was the incorporation of abstracts as a special section of the JOURNAL OF DAIRY SCIENCE.

An agreement has been concluded by the American Dairy Science Association, the International Association of Ice Cream Manufacturers, and the International Association of Milk Dealers which has made it possible for the American Dairy Science Association to publish these abstracts in its Journal and for the other two Associations to make available to its members an enlarged abstract service, published monthly. There will be no break in the continuity of the abstract service of these Associations. In view of the previous yearly publication of abstracts a few months will elapse before the abstracts will be entirely up-to-date as it will be necessary to publish abstracts of articles issued since the appearance of Volume 6 of the ice cream abstracts and Volume 4 of the milk abstracts.

Much thought and effort has been given to this abstract service that it might be of greatest value to the membership of the three Associations, to dairy science, and to the dairy industry. It is not expected that the arrangement for the publication of these abstracts or the abstracts themselves will be ideal for everyone but it is expected and hoped that they will serve the greatest possible number in the fields which they include.

Suggestions and criticisms for the improvement of this service will be appreciated by members of the Committee on Journal Management, by members of the Editorial Committee on abstracts, and by the Editor.

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SOYBEAN FLOUR AS A SUBSTITUTE FOR COW'S MILK IN FEEDING DAIRY CALVES

LAVAN SHOPTAW

Panhandle Agricultural Experiment Station, Goodwell, Oklahoma

One of the sources of continual worry for the dairy farmer and one which has to do with the very life of the industry is the problem of the economical rearing of calves. A vast amount of work has been done to produce calf meals which might displace milk in the diet of the calf. Recent work done in the Orient upon the value of soybean "milk" in infant feeding has raised the question of the adaptability of this material as a feed for young dairy calves.

Tso (1) 1928, reports satisfactory growth of a Chinese baby which was fed from the age of six weeks to that of eight months upon a diet composed chiefly of soybean milk. Again Tso, Yee and Chen (2) 1928, report metabolism trials with two infants in which the nitrogen balance remained positive throughout. Tso also reports (3) 1929, that soybean milk is comparable to cow's milk in vitamin A and richer in vitamin B. Chang and Tso (4) 1931, report data upon the use of a dried soybean milk preparation which resulted in a rate of growth even superior to the standard weight curves for healthy breast-fed babies. Siddall and Chiu (5) 1931, report a feeding experiment upon a Chinese infant extending from an age of six weeks to that of 13 months and 3 weeks, using soybean milk. At the age of 15 months the baby weighed 10 kg. and measured 75 cm. in length. Because of the success that was had in feeding infants on soybean milk, an experiment was planned to determine the effectiveness and economy of using soybean milk as a substitute for cow's milk in rearing dairy calves.

EXPERIMENTAL

Four pairs of calves were used in the experiment, the pairs being matched closely as to weight, height and age. One calf of each pair was used as a check and was fed in a manner approximating common herd practice. The second calf in each pair was fed the same way except that cow's milk was replaced by soybean milk in the calf's ration. The four calves, one from each pair, that were used as checks were designated as group I.

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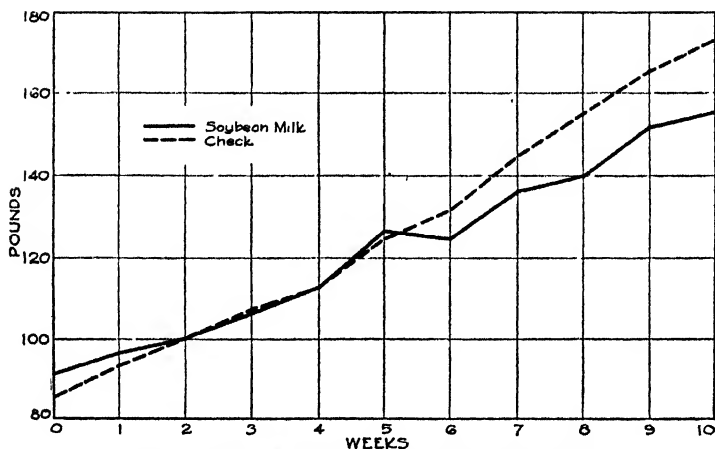


FIG. 1. Showing average gain in pounds per week.

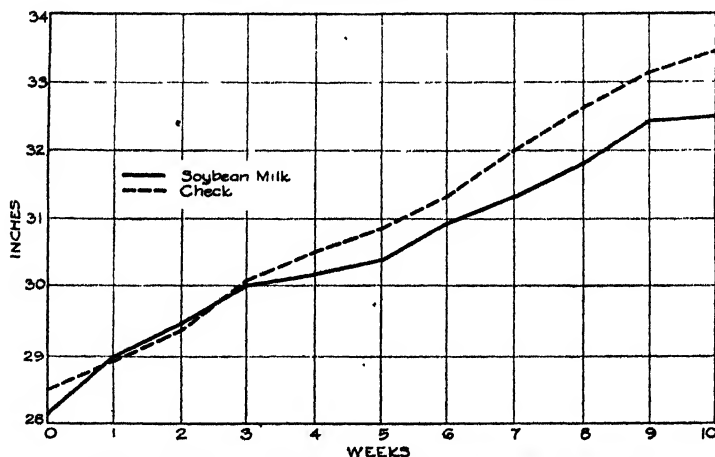


FIG. 2. Showing average gain height (at withers) per week.

Group II was made up of the four calves, one from each pair, that were fed soybean milk.

The soybean milk was prepared by stirring one part of soybean flour into nine parts of warm water. The mixture was fed at body temperature.

All calves were given free access to a grain mixture consisting of 100 pounds corn, 100 pounds bran, 100 pounds milo, 3 pounds lime, 3 pounds bone meal, and 3 pounds salt. Alfalfa hay of good quality was kept before the calves at all times. Access was given to fresh water at all times.

The order of feeding, together with the amounts of feed given, are shown in table I. In most cases the amounts of feed indicated were divided

into two equal feedings and given at about 7 A. M. and 6 P. M. respectively. Care was taken to estimate any feed left by the calves at feeding time.

TABLE 1
Feeding schedule of calves

PERIODS	GROUP I (CHECK)	GROUP II (EXPERIMENTAL)
Preliminary period Birth to 25th day	8 pounds whole cow's milk daily per calf.	8 pounds whole cow's milk daily per calf.
Exp. period 1 to 7 days	8 pounds whole cow's milk daily per calf. Grain and hay ad lib.	Gradual change from 8 lbs. cow's milk daily to 8 lbs. soybean milk daily per calf. Grain and hay ad lib.
8 to 14 days	8½ pounds whole cow's milk daily per calf. Grain and hay ad lib.	8½ pounds soybean milk per calf daily. Grain and hay ad lib.
15 to 21 days	Gradual change from 9 pounds whole milk to 9 pounds skim milk. Grain and hay ad lib.	9 lbs. soybean milk daily per calf. Grain and hay ad lib.
22 to 27 days	9½ lbs. skim milk daily per calf. Grain and hay ad lib.	9½ lbs. soybean milk daily per calf. Grain and hay ad lib.
28 to 42 days	10 lbs. skim milk daily per calf. Grain and hay ad lib.	10 lbs. soybean milk daily per calf. Grain and hay ad lib.
43 to 49 days	10½ lbs. skim milk daily per calf. Grain and hay ad lib.	10½ lbs. soybean milk daily per calf. Grain and hay ad lib.
50 to 56 days	11 lbs. skim milk daily per calf. Grain and hay ad lib.	11 lbs. soybean milk daily per calf. Grain and hay ad lib.
57 to 63 days	11½ lbs. skim milk daily per calf. Grain and hay ad lib.	11½ lbs. soybean milk daily per calf. Grain and hay ad lib.
64 to 70 days	12 pounds skim milk daily per calf. Grain and hay ad lib.	12 lbs. soy bean milk daily per calf. Grain and hay ad lib.

RESULTS

The gains in weight made by the calves fed soybean milk (Group II) were considerably less than those made by the check group (Group I), as is shown in figure 1, the average daily gain made reaching only 0.9 pounds for the soybean fed calves as against an average gain of 1.24 pounds for the check calves. These gains varied in the soybean-milk fed group from 0.7 to 1.16 pounds per day and from 0.84 to 1.54 pounds per day in the check group. The gains in both groups were fairly constant, except that the soybean calves failed to gain during the sixth week of the trial.

Weekly measurements of height at withers were made on both groups of calves. As is shown in figure 2, the increases were less for the soybean-fed

calves, the average height for this group being, at the end of the trial, 32.5 inches, while that of the check group was 33.44 inches. The average weekly increase in height in the soybean fed group ranged from 0.35 to 0.58 inches, with an average for the group of 0.44, while that for the check group also ranged from 0.35 to 0.58 inches but with an average of 0.49 inches for the group.

Two calves of the soybean-fed group refused the soybean milk after 18 and 32 days respectively, while the remaining two calves of this group developed a taste for the milk and took the full amount throughout the trial. The average time on soybean milk for the group was 38.5 days, with an average consumption for the period, of 343.6 pounds each. The average daily consumption was 8.92 pounds.

Group I consumed an average of 8.25 pounds of whole milk per day for the first 14 days of the trial. For the following 42 days they consumed an average of 10.8 pounds of skim milk each per day. One calf of this group refused skim milk after being fed on it five days. These data, together with those concerning grain and hay consumption are tabulated in table II.

TABLE II
Feed consumption of calves

	GROUP I	GROUP II
Time on trial	70 days	70 days
Ave. time on soybean milk		38.5 days
Time on whole milk	14 days	
Ave. time on skim milk	42.3 days	
Ave. daily consumption of—		
Soybean milk		8.92 pounds
Whole cow's milk	8.25 pounds	
Skim milk	10.3 pounds	
Grain	1.57 pounds	2.22 pounds
Hay	0.74 pounds	0.61 pounds

It will be seen that the calves fed soybean milk consumed more grain and slightly less hay than the check calves.

The general health of the calves fed soybean milk was not especially good. A great amount of diarrhea occurred in this group so that gruels of barley were often used to alleviate this condition. The hair coats of these calves were rather more rough than those of the check group.

SUMMARY

Four pairs of calves averaging 25 days of age, were used in a 70-day feeding trial in comparing soybean milk with cow's milk as a feed for dairy calves. Grain and hay were allowed *ad libitum* to both groups. The calves fed soybean milk consumed an average of 343.6 pounds of soybean milk, while the check calves consumed an average of 115.5 pounds of whole milk.

and 459 pounds of skim milk. The soybean fed calves consumed an average of 156 pounds of grain and 43.1 pounds of hay during the trial, while the check calves consumed 110 pounds and 51.8 pounds of grain and hay, respectively during the 70-day period. The average daily gain for the soybean calves was 0.9 pounds while that for the check calves was 1.24 pounds. The soybean calves made an average increase in height (at withers) of 4.37 inches, while the check calves made an increase in height of 4.94 inches during the trial. The soybean calves did not show a thrifty condition throughout the trial and considerable diarrhea was experienced. Also there was some difficulty in getting the calves to relish soybean milk.

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THE AGE THICKENING OF SWEETENED CONDENSED MILK

IV. THE EFFECT OF SALTS*

V. C. STEBNITZ AND H. H. SOMMER

Department of Dairy Industry, University of Wisconsin

The effect of salts on the stability of simple colloidal sols is quite well understood. However, due to the complicated nature of the colloidal system of milk, their effect on the stability of the milk colloids is not so well understood, but has been investigated by a number of workers.

Sommer (1) found that there is an optimum balance between the magnesium and calcium on one hand and the citrates and phosphates on the other hand in order to obtain the maximum heat stability of milk.

Sommer and Binney (2) have shown that magnesium or calcium ions will change alcohol negative milk to alcohol positive milk, while citrate or phosphate ions will change an alcohol positive milk to alcohol negative.

Sommer and Young (3) showed that with certain ice cream mixes the addition of sodium citrate or disodium phosphate before homogenization greatly increases the whipping ability and that additions of calcium lactate decrease the whipping ability.

Henning and Dahlberg (4) found that the addition of sodium citrate and disodium phosphate to ice cream mixes before homogenization decreases the tendency of the fat globules to clump, decreases the viscosity of the mix and increases the whipping ability, while the addition of calcium salts has an opposite effect. They also showed that by the addition of potassium oxalate the calcium salts are precipitated and clumping is prevented entirely.

North and Sommer (5) have shown that the electrical charge on the fat globules is involved in fat clumping and that the addition of positively charged ions decrease the charge on the globules and favors clumping while negatively charged ions have an opposite effect.

Templeton and Sommer (6) reported that the whipping ability of whipping cream is increased by the addition of sodium citrate while calcium salts have an opposite effect.

Tracy and Ruehe (7) have demonstrated that calcium salts affect the feathering of cream in coffee and that feathering can be prevented by the addition of sodium citrate or disodium phosphate.

The destabilizing effect of calcium on milk proteins has also been shown by the work of Van Slyke and Bosworth (8). They found that in neutralizing the excess of lime in a casein-lime-water solution with hydrochloric acid,

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the precipitation of the casein occurs early in the neutralization unless the calcium salts are removed by dialysis.

Tracy and Ruehe (7) have suggested that the decreased stability of milk proteins as the result of homogenization is due to increased adsorption of phosphates (also citrates) at the fat-serum interface, leaving less of these salts in the serum proper.

Rogers, Deysher and Evans (9) found that the addition of calcium citrate has no effect on the subsequent age thickening of sweetened condensed milk, but that phosphates cause a more rapid thickening.

EXPERIMENTAL METHODS

The methods used in these trials for making the condensed milk and measuring the viscosity, hydrogen ion concentration, and electrical conductivity have been described in previous papers (10) and (11).

EFFECT OF ADDING SALTS BEFORE FOREWARMING AS COMPARED TO ADDING THEM TO THE FINISHED PRODUCT

Some preliminary trials in this laboratory showed that the thickening tendency of sweetened condensed milk increased when increasing amounts of calcium acetate or disodium phosphate were added to the finished product, while sodium citrate appeared to have very little, if any, effect in the amounts added.

In further trials the salts were added at the rate of 40 cc. of the M/2 solution to 8 pounds of raw milk. These additions represent 0.031 per cent more CaO, 0.115 per cent more citric acid and 0.039 per cent more P_2O_5 than were present in the original milk.

Table 1 shows the effect of adding the salts to the finished product while Table 2 indicates the results obtained when the salts were added before forewarming. The results obtained by adding the salts to the finished product agree with those of the preliminary trials in which the disodium phosphate and calcium acetate caused a rapid thickening and the sodium citrate had but little, if any, effect. However, when the salts were added before forewarming the results were different, with the exception that disodium phosphate again had an unstabilizing effect. The sodium citrate milk thickened faster than the control while the calcium acetate sample showed but little increase in viscosity after the third day in contrast to the rapid thickening which it caused when added to the finished product.

In numerous other trials which cannot be reported here, the same general results were obtained. However, in trials where the control sample thickened more rapidly than the one shown in Table 2, the addition of either sodium citrate or calcium acetate before forewarming produced a less viscous product than the control. The addition of disodium phosphate always produced a more viscous product. Such results would seem to indicate that the effect of the salt additions is influenced by the original stability of the milk.

TABLE 1
Salts added to stable milk after condensing

PERIOD OF STORAGE	CONTROL	CALCIUM ACETATE	SODIUM CITRATE	DISODIUM PHOSPHATE
<i>Days</i>		<i>Viscosity in Paises</i>		
0	4.9	29.8	6.2	11.14
4	19.5	Too viscous	13.93	Too viscous
6	24.7		19.42	
8	29.7		19.42	
11	29.7		19.42	
13	22.3		24.0	
15	25.1		25.8	
18	30.7		32.0	
20	37.0		37.5	

Forewarming temperature 190.4° F. for 10 minutes.

TABLE 2
Salts added to stable milk before condensing

PERIOD OF STORAGE	CONTROL	CALCIUM ACETATE	SODIUM CITRATE	DISODIUM PHOSPHATE
<i>Days</i>		<i>Viscosity in Paises</i>		
0	7.0	10.3	6.2	7.4
3	10.5	51.0	9.9	230.0
6	19.9	52.6	25.8	Too viscous
10	28.5	54.6	55.8	
12	32.6	54.6	102.0	
14	33.6	46.7	138.8	
19	60.8	69.4	495.5	
21	70.3	59.8	447.0	

Forewarming temperature 190.4° F. for 10 minutes.

THE EFFECT OF ADDING SALTS TO UNSTABLE MILK

The effect of adding these salts to unstable milk before condensing is shown in Table 3. The effect of adding the salts after condensing is shown in Table 4, where the milk used was less stable than that in the trials given in Table 1 and 2, but not as unstable as that shown in Table 3.

These results confirm the indications in the preliminary trials that the addition of sodium citrate is effective in retarding thickening when added to milk which is originally unstable regardless of whether the salt is added before forewarming or to the finished product.

The addition of calcium acetate to unstable milk before forewarming was effective in preventing the subsequent rapid thickening of the finished product, but the condensed milk was not normal. There was considerable flaking of the casein on the inside of the condensing flask and small pieces of curd were left in the hot well after forewarming. However, the finished product usually appeared quite smooth. Adding the calcium acetate after condens-

ing caused the milk to thicken very rapidly; in one instance the milk became so viscous after adding this salt solution that it was impossible to obtain a reading for the initial viscosity.

The thickening caused by the addition of disodium phosphate was not so rapid as might have been expected from its effect on stable milk. In some trials with very unstable milk the phosphate had a slight stabilizing effect.

TABLE 3
Salts added to unstable milk before condensing

PERIOD OF STORAGE	CONTROL	CALCIUM ACETATE	SODIUM CITRATE	DISODIUM PHOSPHATE
<i>Days</i>		<i>Viscosity in Poises</i>		
0	6.2	7.5	4.9	4.9
2	395.0	85.5		25.1
5	807.5	100.4	39.1	1121.0
10	Too viscous	121.3	52.7	Too viscous
14		113.0	55.5	
17		117.2	41.6	
26		156.6	44.6	

Forewarming temperature 190.4° F. for 10 minutes.

TABLE 4
Salts added to relatively stable milk after condensing

PERIOD OF STORAGE	CONTROL	CALCIUM ACETATE	SODIUM CITRATE	DISODIUM PHOSPHATE
<i>Days</i>		<i>Viscosity in Poises</i>		
0	6.2	468.0	4.9	6.2
1		Solid		
2	44.5		11.1	16.7
4	165.5		13.9	320.0
9	468.7		27.7	Too viscous
13	267.9		30.7	
16	217.0		41.6	
25	420.0		93.1	
30	511.4		217.0	

Forewarming temperature 190.4° F. for 10 minutes.

EFFECT OF ADDING VARYING AMOUNTS OF THE SALTS

In the preceding trials 40 cc. of the M/2 salts solutions were used to an 8-pound batch of the raw milk or its equivalent of finished product. It has been shown by Sommer (1) that there is an optimum salt balance which produces the greatest stability in evaporated milk. It is not unreasonable to expect that possibly such an optimum also exists for sweetened condensed milk.

Calcium Acetate: Table 5 shows the effect of adding varying amounts of calcium acetate to batches of unstable milk before forewarming. The con-

TABLE 5
M/2 calcium acetate added to unstable milk before forewarming

PERIOD OF STORAGE	CONTROL	CC PER 8 POUND BATCH				
		5 cc	10 cc	20 cc	30 cc	40 cc
<i>Days</i>			<i>Viscosity in Poises</i>			
0	6.2	31.2	18.5	4.9*	6.2	6.2
1	151.0	**	**	156.0	13.6	9.8
4	**	.	.	395.0	14.9	11.1
6		.	.	402.0	25.1	13.9
11		.	.	468.0	36.4	22.3
16		.	.	511.4	41.6	22.3
20				640.0	36.4	22.7
22				**	36.4	33.6

* Slight flaking observed.

** Too viscous.

Additions of 60 and 80 cc. of the M/2 caused the milk to coagulate and whey off during the forewarming.

Forewarming temperature 190.4° F. for 10 minutes.

trol batch was too viscous to measure at the end of 4 days. The addition of 5 and 10 cc. of the M/2 salt to an 8-pound batch of milk made the finished product still more unstable and there was no flaking of the casein during forewarming and condensing. The first flaking was observed with the addition of 20 cc. and with this concentration of salt the tendency of the milk to thicken was greatly decreased. Larger additions of 30 and 40 cc. to a batch made the milk still less viscous, but induced a more pronounced flaking during forewarming and condensing. Additions of 60 and 80 cc. caused the milk to coagulate completely and to whey off during the forewarming.

The effect of varying amounts of calcium acetate on more stable milk is shown in Table 6. In these trials with stable milk the calcium acetate failed

TABLE 6
Calcium acetate added to stable milk before forewarming

PERIOD OF STORAGE	TO 8 POUNDS OF MILK			
	Control	½ gram	1 gram	3 grams
<i>Days</i>		<i>Viscosity in poises</i>		
0	6.2	6.2	7.4	7.4
2	39.0	253.4	108.8	83.9
3	50.1	372.5	83.9	83.9
6	64.4	545.6	92.0	114.6
13	86.4	740.1	190.0	234.4
17	111.5	684.3	156.6	218.8
21	120.0	643.0	189.5	198.0
27	204.1	1165.0	209.5	247.8

Sucrose 44.1 per cent, fat 7.70 per cent, milk solids-not-fat 18.99 per cent.

Forewarming temperature 185° F. for 10 minutes.

to produce a less viscous milk but actually caused the milk to thicken more rapidly, especially when small amounts were used. Other trials, not reported here, have shown that the optimum amount of calcium acetate necessary to produce maximum thickening in the finished product varied with the milk.

The temperature of forewarming unstable milk treated with calcium acetate was found to influence the effect of the calcium on the subsequent thickening. Forewarming at 190° F. for ten minutes produced a product which was less viscous and thickened less rapidly than forewarming at 185° F. for ten minutes.

In the next trial (Table 7) calcium acetate, calcium hydroxide and cal-

TABLE 7
Various calcium salts added before forewarming

PERIOD OF STORAGE	CONTROL	3.5 G. CA ACETATE	1.17 G. CA(OH) ₂	6.13 G. CA LACTATE
	6.50	pH after adding sugar and salts		
		6.32	6.87	6.31
<i>Days</i>		<i>Viscosity in poises</i>		
0	38.4	11.55	4.94	12.4
1	1488.0	282.6	6.2	2120.0
2	Too viscous	1933.0	6.2	Too viscous
6		Too viscous	11.55*	
15			13.93	
20			13.93	

* Visible fat separation.

Forewarming temperature 190.4° F. for 10 minutes.

cium lactate were added to batches of milk in amounts so that each batch contained the same amount of added calcium. The salts were added as a solution to the milk before forewarming to 190.4° F. for ten minutes. The condensed milk containing the calcium hydroxide remained very fluid; in fact, it had such a low viscosity that at the end of six days a visible layer of fat about 1 centimeter deep had risen to the top of the tube. This low viscosity was no doubt due to the increase in pH caused by the added hydroxide. The calcium acetate retarded the thickening somewhat, while the calcium lactate exerted but little, if any, effect. The calcium acetate and the calcium lactate made the milk somewhat more acid. The effect of each of these three salts on the reaction is shown in Table 7.

Sodium Citrate: The effect of adding varying amounts of sodium citrate to the milk before forewarming is shown in Table 8. With increasing amounts of sodium citrate the thickening tendency was decreased. Other trials in which smaller additions than 2 grams to an 8-pound batch were used, failed to show any effect of the citrate. The viscosity of the batch contain-

TABLE 8
Varying amounts of sodium citrate added before forewarming

PERIOD OF STORAGE	CONTROL	TO 8 POUNDS OF MILK		
		2 grams	4 grams	12 grams
<i>Days</i>		<i>Viscosity in poises</i>		
0	6.2	6.2	4.94	4.94
1	11.55	11.55	11.55	8.7
5	98.0	70.0	67.0	21.5
10	407.7	195.3	209.5	44.6
14	545.6	273.1	258.1	39.6*
19	573.0	432.0	372.5	54.5

Sucrose 44.1 per cent, fat 7.52 per cent, milk solids-not-fat 20.83 per cent.

* Visible fat separation.

Forewarming temperature 185° F. for 10 minutes.

ing the 12 grams of sodium citrate was so low that visible fat separation occurred.

Disodium Phosphate: The effect of adding varying amounts of disodium phosphate to unstable and stable milk is shown in Tables 9 and 10. With

TABLE 9
Disodium phosphate added to unstable milk before forewarming

PERIOD OF STORAGE	CONTROL	TO 8 POUNDS OF MILK		
		1/2 gram	2 grams	8 grams
<i>Days</i>		<i>Viscosity in poises</i>		
0	17.3	7.4	6.2	6.2
1	1038.0	138.5	740.1	39.0
4	Too viscous	Too viscous	Too viscous	Too viscous

Sucrose 44.1 per cent, fat 8.05 per cent, milk solids-not-fat 20.8 per cent.

Forewarming temperature 185° F. for 10 minutes.

TABLE 10
Disodium phosphate added to stable milk before forewarming

PERIOD OF STORAGE	CONTROL	TO 8 POUNDS OF MILK		
		1/2 gram	1 gram	2 grams
<i>Days</i>		<i>Viscosity in poises</i>		
0	7.4	6.2	6.2	6.2
1	8.7	8.7	13.6	13.6
4	11.55	17.3	67.0	95.0
8	13.93	22.3	138.8	940.6
13	16.75	25.8	221.5	1933.0
18	16.75	28.4	195.3	2478.0
22	16.75	33.5	232.0	Too viscous

Sucrose 44.1 per cent, fat 8.09 per cent, milk solids-not-fat 17.61 per cent.

Forewarming temperature 185° F. for 10 minutes.

stable milk increasing amounts of phosphate increased the thickening tendency during storage. With the unstable milk used in Table 9 the batch containing the 8 grams of disodium phosphate was actually not as viscous as the batches with the smaller amounts of phosphate. The slight stabilizing effect of phosphate on very unstable milk was also noticed in previous trials.

THE EFFECT OF SALT ADDITIONS ON THE HYDROGEN ION CONCENTRATION
DURING THE PREPARATION AND AGING OF SWEETENED
CONDENSED MILK

The effect of salts on the pH during various stages in the manufacture and aging of sweetened condensed milk is shown in Figure 1. The fresh, raw milk used in these trials had a pH of 6.62. The addition of 18.75 per cent sucrose caused the pH to drop to 6.57. The addition of 40 cc. M/2 calcium acetate to 8 pounds of milk lowered the pH to 6.44, while the addition of 40 cc. M/2 sodium citrate and 40 cc. M/2 disodium phosphate raised the reaction to pH 6.69 and pH 6.72 respectively.

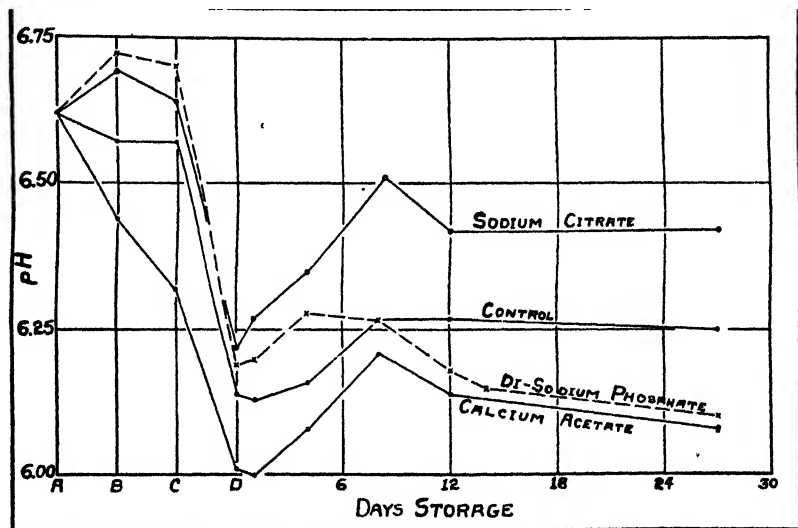


FIG. 1. The effect of salt additions on the hydrogen ion concentration during the preparation and aging of sweetened condensed milk.

A—raw milk.

B—raw milk sucrose plus salt addition.

C—after forewarming at 88° C. (190.4° F.) for 10 minutes.

D—after condensing.

Forewarming at 88° C. (190.4° F.) for 10 minutes lowered the pH of the sodium citrate and disodium phosphate batches to 6.64 and 6.70 respectively. The calcium acetate batch showed a more pronounced drop in pH

than the sodium citrate and disodium phosphate batches. The reaction of the milk treated with calcium acetate at the end of the forewarming was pH 6.32. Once, when the raw milk had an abnormally high acidity (pH 6.27), the addition of calcium acetate caused complete coagulation during forewarming. The control sample in this trial failed to change in pH during forewarming, although numerous other trials usually showed a slight drop.

As might be expected, condensing caused a decided decrease in pH of all samples. In this connection it is interesting to note that although the pH of the phosphate sample was above that of the citrate sample after forewarming, this order was reversed at the end of the condensing period. At the end of the condensing period the reactions of the batches were as follows: sodium citrate pH 6.22, disodium phosphate pH 6.19, control pH 6.13 and calcium acetate pH 6.01.

At the end of the first day of storage the control and calcium acetate batches showed further slight decreases in pH, while the sodium citrate and disodium phosphate batches became more alkaline. As aging progressed the batches of condensed milk became more alkaline, reached a maximum and then declined. The control, sodium citrate and calcium acetate batches reached their maximum pH values at the end of 8 days storage at 37° C. (98.6° F.). The disodium phosphate batch reached its maximum pH somewhat sooner than the other batches.

At the end of the condensing period the phosphate batch was more alkaline than the control but during the aging process this order was reversed and the phosphate batch became nearly as acid as the calcium acetate batch. Six other trials all showed that by the end of the aging period the pH of the phosphate batches was lower than the control batches. This increase in acidity of the phosphate milk is probably due to the precipitation of tricalcium phosphate. In a medium such as sweetened condensed milk undoubtedly equilibrium is attained slowly.

CORRELATION OF THE ALCOHOL TEST WITH THE TENDENCY OF SWEETENED CONDENSED MILK TO THICKEN DURING AGING

Sommer and Binney (2) have shown that the alcohol test is influenced by the mineral constituents of the milk. In an effort to correlate the alcohol test with the tendency of sweetened condensed milk to age thicken, the milks of individual cows of the University herd were tested in order to find one cow giving milk which would be consistently alcohol positive, and another giving alcohol negative milk. Two Jerseys were selected, Gertrude, No. 80, alcohol positive, and Miss Cid, No. 89, alcohol negative. The milks of these two cows were quite similar in all respects except the alcohol test.

The milks of both of these two cows were very unstable to age thickening after being condensed. The addition of disodium phosphate to the alcohol positive milk made the milk less stable, while, with the alcohol negative milk,

it had a slight stabilizing effect. Calcium acetate was not effective in stabilizing the alcohol positive milk but was quite effective in decreasing the tendency of alcohol negative milk to thicken. Sodium citrate was quite effective in decreasing the tendency of both milks to thicken, especially the alcohol positive milk. There was a marked decrease in viscosity after the first day when sodium citrate had been added to alcohol positive milk, as shown in Table 13. This was probably due to a change in the equilibrium of the milk during storage. The results of these trials are shown in Tables 11, 12, and 13. In each trial 40 cc. of the M/2 salt were added before forewarming.

TABLE 11
Effect of disodium phosphate

PERIOD OF STORAGE	GERTRUDE Alcohol positive		MISS CUD Alcohol negative	
	Control	Disodium phosphate	Control	Disodium phosphate
<i>Days</i>	<i>Viscosity in poises</i>			
0	132.0	211.0	28.1	12.4
1	Too viscous	Too viscous	Too viscous	125.0
4			Solid	Too viscous

Forewarming temperature 190.4° F. for 10 minutes.

40 cc. M/2 disodium phosphate to 8 pounds of raw milk before forewarming.

TABLE 12
Effect of calcium acetate

PERIOD OF STORAGE	GERTRUDE Alcohol positive		MISS CUD Alcohol negative	
	Control	Calcium acetate	Control	Calcium acetate
<i>Days</i>	<i>Viscosity in poises</i>			
0	31.6	44.6	16.7	20.9
1	Too viscous	Too viscous	Too viscous	625.0
2				511.2
5				401.8
7				312.5
10				468.7
13				562.5
19				807.5
26				Too viscous

Forewarming temperature 190.4° F. for 10 minutes.

40 cc. M/2 calcium acetate to 8 pounds of raw milk before forewarming.

In the next experiment two Holstein cows were selected, Cow 71 giving alcohol positive milk and Cow 72 alcohol negative milk. These cows were on an experimental ration containing 0.66 per cent ground limestone and

TABLE 13
Effect of sodium citrate

PERIOD OF STORAGE	GERTRUDE Alcohol positive		MISS CUD Alcohol negative	
	Control	Sodium citrate	Control	Sodium citrate
<i>Days</i>		<i>Viscosity in poises</i>		
0	27.5	23.3	13.9	13.9
1	Too viscous	330.9	Too viscous	44.5
2		197.7		83.3
3		187.5		117.2
6		90.4		102.1
8		70.3		117.2
11		58.6		175.8
14		67.3		186.1
20		44.5		166.5
30		47.2		263.7
37		64.3		243.4

Forewarming temperature 190.4° F. for 10 minutes.

40 cc. M/2 sodium citrate to 8 pounds of raw milk before forewarming.

2.50 per cent lime phosphate. Three Holstein cows were on this ration, two of which gave alcohol positive milk and the other alcohol negative milk. The other Holstein cows of the University herd were on a normal ration and their milks were all alcohol negative. It seems that the high mineral ration that these cows were fed had the tendency to change the milk from alcohol negative to alcohol positive.

In these trials the hydrogen ion concentration as well as the electrical conductivities were determined. The electrical conductivity of the alcohol positive milk was 72.7×10^{-4} while with the alcohol negative milk it was 63.8×10^{-4} . Whether or not alcohol positive milk always has a higher electrical conductivity is not known as only these two trials were made. The pH and conductivity measurements during the process of manufacture and aging of these two sweetened condensed milks showed no relation to the stability of the product.

Both of these milks were relatively unstable. The addition of 40 cc. of M/2 calcium acetate to a batch of alcohol positive milk (Table 14) caused complete coagulation of the milk during forewarming. This same trial was repeated at a later date with the same results. The addition of calcium acetate to the alcohol negative milk (Table 15) caused a slight stabilization. The stabilizing effect of the sodium citrate on the alcohol negative milk was very marked, while with the alcohol positive milk the sample containing the citrate thickened faster than the control. However, had the viscosity measurements on the sample been continued for a longer period it is possible that the viscosity would have decreased again as it did in the previous trial, shown in Table 13.

TABLE 14
Effect of alcohol + milk on the changes in pH, conductivity and viscosity

TO 8 LBS. MILK	CONTROL				40 CC M/2 SODIUM CITRATE				40 CC M/2 CALCIUM ACETATE			
	Tit. Acid	Kx10 ⁴	pH	Visc.	Tit. Acid	Kx10 ⁴	pH	Visc.	Tit. Acid	Kx10 ⁴	pH	Visc.
Fresh milk	%	Mhos.		Poises	%	Mhos.		Poises	%	Mhos.		Poises
Milk + sucrose	0.16	72.7	6.52		0.16	72.7	6.52		0.16	72.7	6.52	
+ Salts	0.14	48.3	6.42		0.14	48.3	6.42		0.14	48.3	6.42	
After prewarming	0.14	48.3	6.27		0.135	50.0	6.56		0.14		6.28	
After condensing		9.74	5.77	9.9	0.135	53.2	6.51		Coagulated during forewarming			
Days						8.3	6.00					
2		6.38	5.76	311.6		5.63	5.81	2970.0				
6		6.97	5.78	3510.0		6.27	6.15	*				
22		6.10	5.88	*		5.62	6.18					

This alcohol + milk was from cow 71.

Forewarming temperature 190° F. for 10 minutes.

* Too viscous to measure.

TABLE 15
Effect of alcohol—milk on the changes in pH, conductivity and viscosity

TO 8 LBS. MILK	CONTROL				40 CC. N/2 SODIUM CITRATE				40 CC. N/2 CALCIUM ACETATE			
	Tit. Acid	K $\times 10^4$	pH	Visc.	Tit. Acid	K $\times 10^4$	pH	Visc.	Tit. Acid	K $\times 10^4$	pH	Visc.
	%	Mhos.		Poises	%	Mhos.		Poises	%	Mhos.		Poises
Fresh Milk	0.14	63.8	6.04		0.14	63.8	6.64		0.14	63.8	6.64	
Milk + sucrose	0.12	41.8	6.59		0.12	41.8	6.59		0.12	41.8	6.59	
+ Salts					0.12	43.2	6.71		0.14	44.8	6.28	
After prewarming	0.12	40.7	6.48		0.115	45.8	6.68		0.14	44.8	6.28	
After condensing		4.53	6.08	643.0		5.0	6.22	22.3		7.8	5.88	60.1
Days												
2		4.52	6.05	*		4.9	6.18	37.2		4.9	5.9	*
5		5.20	6.12			5.81	6.22	188.5		5.52	5.97	
9		6.37	6.15	Solid		6.12	6.28	188.5		6.92	6.00	
26		4.48	6.15			5.48	6.38	323.0		6.05	6.14	

This alcohol + milk was from cow 72.

Prewarming temperature 190° F. for 10 minutes.

* Too viscous to measure.

DISCUSSION

Because of the numerous factors involved and the limited number of data available, it is impossible, at present, to formulate a theory to account for the action of the salts on the thickening of sweetened condensed milk. It has been shown in this paper that the effect of the salts is influenced by the following factors: (1) the relative stability of the original milk, (2) the addition of salts to the milk before forewarming or to the finished product, (3) the temperature of forewarming, (4) the amount of salt added, and (5) the effect of the salt on the reaction of the milk.

The effect of calcium acetate in decreasing the thickening tendency of unstable mixed milk cannot be attributed to a stabilizing effect. This effect becomes apparent only when the amount of calcium acetate is great enough and the temperature high enough to produce a visible flaking of the casein. It appears that this partial coagulation of the casein prevents its subsequent gelation. Larger amounts of calcium acetate cause complete coagulation. When the calcium is added in the form of calcium hydroxide the effect of the increase in pH overshadows the effect of the calcium.

The unstabilizing effect of disodium phosphate cannot be attributed to its ability to decrease the pH of the milk during aging as this does not occur until after several days of storage while the thickening begins immediately.

The results of Rogers, Deysher, and Evans (9), that added phosphates cause a more rapid thickening are in accord with the results reported in this paper. Their results also show that increasing the citrate by 28 per cent had no effect upon the subsequent thickening but the citrate salt was added in the form of calcium citrate so that any effect which might be expected from the citrate ion would be opposed by the calcium ion.

A satisfactory explanation of the effect of the salts must await a better understanding of the physico-chemical equilibrium of milk and its concentrated products.

CONCLUSIONS

Stable sweetened condensed milk cannot be further stabilized by the addition of sodium citrate, disodium phosphate, or calcium acetate.

Unstable milk may be stabilized by the addition of sodium citrate to the milk either before forewarming or to the finished product after condensing. The addition of disodium phosphate to unstable milk before forewarming has a very slight stabilizing effect.

The addition of calcium acetate or disodium phosphate to prepared sweetened condensed milk causes a rapid thickening.

There is no correlation between the alcohol test and the stability of sweetened condensed milk toward age thickening.

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NUTRITIONAL ANEMIA IN RATS ALLEVIATED BY EVAPORATED MILK AND IRON

HERMANN B. STEIN, MORTON H. RADETSKY, AND ROBERT C. LEWIS

*Departments of Pediatrics and Biochemistry of the University of Colorado
School of Medicine, Denver*

The commercial preparation of evaporated milk involves practically a continuous contact of the milk with metal—either copper, tinned copper, bronze, or in the more recently equipped plants, monel metal. Inasmuch as bronze usually contains more than 70 per cent copper, and monel metal (1) 27 per cent, it is seen that copper is the predominant metal with which the milk comes in contact during the manufacturing process. Analyses of processed milk by Supplee and Bellis (2), Rice and Miscall (3), and Quam and Hellwig (4) have shown an increased copper content over that of raw milk. The problem of whether the amount of copper in evaporated milk is sufficient to prevent or cure nutritional anemia when the milk is supplemented with iron has a practical bearing, since nutritional anemia in infancy is a well known clinical entity, and particularly in view of the fact that the use of evaporated milk in infant feeding has increased considerably during recent years. In a previous publication from our laboratories (5) it has been reported that a nutritional anemia will develop in albino rats fed an exclusive diet of evaporated milk, although the anemia is produced less rapidly than with raw milk. This slower rate of development of the anemia was attributed to the erythropoietic action of the copper contained in the evaporated milk, since raw milk to which copper was added produced a similar retardation in the development of the anemia. However, as none of these animals received iron, no cure of the nutritional anemia was effected. The present study was conducted to determine whether the nutritional anemia produced by raw milk could be cured by feeding evaporated milk and purified iron.

EXPERIMENTAL

Sixteen groups of weanling albino rats, 21 days old, were placed separately in glass cages with wire bottoms and given unsupplemented raw milk *ad libitum* until they became anemic. The milk was obtained from a neighboring dairy. A worker from the department supervised each collection, which was made by expressing the milk directly from the cow into wide-mouthed jars. The cage was essentially the same as that described and illustrated in the previous publication (5). However, instead of using a floor of glass rods which would favor the retention of the animal discharges when diarrhea occurred, a wide-meshed galvanized wire screen was substi-

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tuted to avoid coprophagy. For the top, the glass was enclosed in the wooden frame described by Underhill, Orten, and Lewis (6).

When the hemoglobin had fallen to approximately 4 gm. per 100 cc. of blood (in most cases below this figure), a change was made to diluted evaporated milk. Each group of rats except the control group received evaporated milk from a different manufacturing plant, as noted below. Coincident with the change to evaporated milk, 0.5 mg. of iron was added to a small amount of milk each morning, and when this was entirely consumed the milk was given *ad libitum*. In the case of the control group the same amount of iron was given daily, and the raw milk was continued. The rats were weighed weekly, and hemoglobin determinations and erythrocyte counts were made at intervals varying from 7 to 14 days. The method of obtaining blood and the hematological procedures used were the same as those described in an earlier paper (5).

The iron was fed as ferric chloride in an aqueous solution of such strength that 0.5 cc. contained 0.5 mg. of iron. The ferric chloride had been especially prepared in our laboratory and had been found to be free from any copper contamination by spectroscopic examination¹ and by feeding as a supplement to anemic rats on a raw milk diet.

The evaporated milk was obtained through the courtesy of the Evaporated Milk Association from five of the larger manufacturers. Each company supplied us gratuitously with specimens from three of their plants. This made the milk representative of that purchasable on the open market throughout the United States. The following states were represented: New York, Pennsylvania, Ohio, Tennessee, Illinois, Wisconsin, Kansas, Colorado, Oregon and California, as illustrated on the accompanying map (Fig. 1). Each evaporated milk has been designated by a letter to represent the brand and by a figure to denote the particular plant from which the milk was supplied; thus milks A-1, A-2, and A-3 were from three different plants of the same manufacturer. Two of the fifteen evaporated milks used, milks A-2 and B-2, were irradiated. Each experimental group of animals has been designated by the letter-number combination of the milk fed.

The evaporated milk was prepared as required by dilution with an equal amount of water distilled from glass, and this diluted milk was kept in small wide-mouthed jars. Both the raw milk and the evaporated milk were kept in the refrigerator. The halves of standard Petri dishes used for feeding were washed in soap and water, placed in approximately 10 per cent nitric acid for 24 hours, rinsed in water distilled from glass, and finally allowed to drain and to dry. The milk was transferred to the feeding dishes by one-ounce "Asepto"² syringes, which were easily used and cleaned. The

¹ We are indebted to Professor H. B. Van Valkenburgh of the Department of Chemistry for the spectroscopic analysis of the ferric chloride.

² Becton, Dickinson and Company, Rutherford, New Jersey.



FIG. 1. Map to show geographical distribution of sources of evaporated milk.

syringes and glass jars for storage were cleaned by rinsing in water distilled from glass or by the method used for the feeding dishes.

RESULTS

The three control animals which were fed only the raw milk and iron after the hemoglobin had fallen below 4.0 gm. per 100 cc. of blood showed a transitory rise both in the hemoglobin and erythrocyte count (*cf.* Table 1). However, there was not sufficient response to keep the animals from further decline and death. These results confirm previous observations (6, 8, 9, 10, 11, 12, 13) that purified iron alone, when fed to rats made anemic on raw milk, will not cure nutritional anemia.

Forty-eight rats were given the evaporated milk and iron as shown in Table 1. The data from eleven of these animals were not used in the interpretation of results, inasmuch as death occurred within three weeks. It must be remembered that this type of experimental feeding lowers the individual resistance of the rats to a marked degree, so it is not surprising that some failed to survive a sufficient length of time to allow any conclusion to be reached.

Thirty-seven animals were carried long enough to accumulate data for analysis. A return of the hemoglobin and erythrocytes to 80 per cent of the normal or above has been arbitrarily considered as complete recovery. The figures utilized as normals for the calculation of "Percentage Hemoglobin" and "Percentage Erythrocytes" given in Table 1 are based upon the results obtained by Underhill, Orten, Mugrage, and Lewis (14). They found that,

TABLE 1
The effect on hemoglobin and erythrocytes produced by feeding evaporated milk and iron to anemic rats.

GROUP AND EVAPORATED MILK FED	RAT	EXPERI- MENTAL PERIOD WEEKS	HEMOGLOBIN				ERYTHROCYTES				REMARKS
			Initial gm. per 100 cc.	Final gm. per 100 cc.	Maximum		Initial millions per cu. mm.	Final millions per cu. mm.	Maximum		
					gm. per 100 cc.	per cent			millions per cu. mm.	per cent	
Control (Raw Milk)	21	2	3.6	2.9	4.6	32.2	3.3	2.7	3.9	48	Data discarded
	32	8	3.4	5.0	5.5	38.5	2.9	4.8	5.3	65	Data discarded
	2	5	3.8	4.2	4.4	30.8	3.1	2.4	3.8	47	Data discarded
A-1	33	3*	3.8	4.3	6.6	46.2	3.0	3.5	6.3	77	Data discarded
	37	12	4.0	10.6	10.6	74.2	3.5	7.0	7.1	87	Fair recovery
	27	2*	3.5	5.5	5.5	38.5	2.9	5.5	5.5	67	Data discarded
A-2	47	12	3.5	11.0	13.6	95.2	2.8	7.3	8.1	100	Complete recovery
	48	12	3.6	12.8	13.4	93.8	3.1	5.6	7.8	96	Complete recovery
	50	12	3.6	12.0	13.2	92.4	3.0	7.8	8.5	105	Complete recovery
A-3	74	11	3.8	6.4	9.0	63.0	2.9	5.0	7.1	87	Fair recovery
	76	8	3.9	14.0	14.0	98.0	3.7	9.6	10.6	130	Complete recovery
	97	9	3.9	14.0	14.0	98.0	3.6	10.3	10.3	127	Complete recovery
B-1	23	9	3.9	12.3	16.1	112.7	4.0	10.3	10.5	129	Complete recovery
	25	9	3.5	14.5	15.0	105.0	3.8	8.5	9.0	111	Complete recovery
	38	9	3.6	9.8	12.9	90.3	3.5	8.1	8.3	102	Complete recovery
B-2	60	8	3.7	14.0	14.0	98.0	3.8	8.4	8.4	103	Complete recovery
	61	6	4.0	13.0	13.0	91.0	3.5	8.5	8.5	105	Complete recovery
	66	2*	3.5	5.8	5.8	40.6	2.3	4.0	4.0	49	Data discarded
B-3	77	8	3.6	14.1	16.0	112.0	3.3	8.3	10.1	124	Complete recovery
	78	8	3.8	15.8	15.9	110.6	3.5	8.6	10.4	128	Complete recovery
	79	8	3.5	13.8	13.8	96.6	3.0	8.4	10.2	125	Complete recovery
C-1	3	13	3.2	14.0	16.8	117.6	2.4	9.1	10.0	123	Complete recovery
	4	13	2.9	10.0	10.0	70.0	2.9	6.6	8.1	100	Fair recovery
	5	13	2.9	11.3	11.5	80.5	2.5	7.9	8.3	102	Complete recovery
C-2	63	5	4.0	8.1	8.1	56.7	3.1	7.4	7.4	91	Fair recovery
	64	11	3.5	16.0	16.0	112.0	2.5	10.5	11.6	143	Complete recovery
	65	2*	4.0	8.1	8.1	56.7	2.7	7.1	7.1	87	Data discarded
	73	11	3.0	13.0	13.0	91.0	4.1	9.9	9.9	122	Complete recovery

* This rat lived three weeks or less, so the data on it were not used in the interpretation of results.

TABLE 1.—(Continued)
The effect on hemoglobin and erythrocytes produced by feeding evaporated milk and iron to anemic rats.

GROUP AND EVAPORATED MILK FED	RAT	EXPERI- MENTAL PERIOD WEEKS	HEMOGLOBIN				ERYTHROCYTES				REMARKS
			Initial gm per 100 cc.	Final gm per 100 cc.	Maximum		Initial millions per cu mm.	Final millions per cu mm.	Maximum		
					gm per 100 cc.	per cent			millions per cu mm.	per cent	
C-3	81	2*	3.8	7.8	7.8	54.6	3.1	6.8	6.8	84	Data discarded
	89	2*	3.6	6.2	6.2	43.4	3.0	4.7	4.7	58	Data discarded
	96	9	3.5	13.8	13.8	96.6	3.9	10.3	10.3	127	Complete recovery
D-1	6	11	3.1	13.2	15.0	105.0	2.4	7.8	8.7	107	Complete recovery
	7	11	2.7	13.2	13.2	92.4	2.5	7.7	7.7	95	Complete recovery
	14	11	2.9	13.8	14.0	98.0	2.6	8.1	9.0	111	Complete recovery
D-2	67	2*	3.9	5.8	5.8	40.6	3.5	6.0	6.0	74	Data discarded
	68	12	2.0	10.5	12.7	88.9	3.1	9.3	9.7	119	Complete recovery
	69	4	4.0	6.3	12.8	89.6	3.7	5.5	7.4	91	Complete recovery
	92	2*	3.4	4.0	4.0	28.0	3.3	4.3	4.3	53	Data discarded
D-3	83	8	3.0	15.0	15.0	105.0	3.0	9.9	9.9	122	Complete recovery
	84	8	4.0	16.4	16.4	114.8	3.0	10.1	10.1	124	Complete recovery
	85	8	3.9	16.9	16.9	118.3	3.9	9.6	10.9	134	Complete recovery
E-1	16	9	3.7	2.0	8.2	57.4	3.7	2.0	5.0	61	Fair recovery
	62	7	3.5	15.3	15.3	107.1	3.7	8.4	8.4	103	Complete recovery
	58	10	2.9	10.8	13.0	91.0	2.6	8.4	8.4	103	Complete recovery
E-2	70	8	3.0	8.7	8.7	60.9	3.1	5.9	5.9	73	Fair recovery
	71	8	4.0	8.2	8.2	57.4	3.7	5.8	5.8	71	Fair recovery
	72	2*	3.5	3.6	3.6	25.2	2.9	3.4	3.4	42	Data discarded
	98	6	3.8	16.0	16.0	112.0	3.4	10.5	10.5	129	Complete recovery
E-3	88	10	4.0	13.0	13.1	91.7	3.9	11.5	11.9	146	Complete recovery
	90	2*	3.3	5.0	5.0	35.0	3.1	2.6	2.6	32	Data discarded
	91	3*	3.7	6.0	6.0	42.0	3.5	5.0	5.0	62	Data discarded

* This rat lived three weeks or less, so the data on it were not used in the interpretation of results.

when rats made anemic on raw milk were given a supplement of iron and copper for a prolonged period of time, the average hemoglobin after recovery reached 14.7 gm. per 100 cc. of blood, and the red cell average, 8,133,000 per cu. mm. Thirty of our thirty-seven rats showed recovery of both erythrocytes and hemoglobin to values within this normal limit, while seven showed partial recovery.

An analysis of the data of the seven rats that did not recover to a point within normal limits yields interesting observations. Rats 74 and 4 had red cell counts well above 80 per cent, although the hemoglobin values were below this figure. Rat 63 was showing a recovery in weight and in the blood picture when death occurred in the fifth week due to an intercurrent infection. Since the group mates of all three of these rats showed complete regeneration of hemoglobin and erythrocytes, it can be concluded that the failure of these animals to recover is not attributable to a lack of hematopoietic substance in the milk (A-3, C-1, and C-2, respectively) which each received. Rat 37 showed a return of the erythrocyte count to above 80 per cent, but the hemoglobin response was not as great. Since its group mates, Rats 33 and 27, lived less than three weeks, no conclusion can be drawn from the results on these two animals concerning the hematopoietic properties of milk A-1. However, the fact that Rat 37 showed a final erythrocyte value of 87 per cent and a hemoglobin value of 74 per cent indicates that this milk possessed definite hematopoietic properties. Rat 16 showed a significant response for the first three weeks, after which there was a loss of weight and a fall in hemoglobin. Although this animal lived six weeks longer, the weight remained low and the blood values had been reduced markedly when death occurred. There was nothing in the autopsy findings on this animal to indicate the cause of death. Since Rats 58 and 62 were fed the same milk as Rat 16 and showed complete recovery, it can be concluded that a lack of hematopoietic substance in the milk was not responsible for the negative results in Rat 16. Rats 70 and 71 were making slow but steady increases in hemoglobin, red cells, and weight when they had to be killed at the end of eight weeks on account of an exhausted milk supply. The fact that their companion, Rat 98, made complete recovery on the same milk in six weeks shows that the milk possessed hematopoietic properties. Thus, it may be concluded from the above analysis that the failure of these seven rats to recover completely cannot be attributed to a lack of hematopoietic substance in the evaporated milk.

The data on the animals of groups A-2 and B-2 which received irradiated evaporated milk showed nothing which would indicate that the irradiated milk had any different effect on the blood picture than unirradiated milk.

DISCUSSION

When this study was undertaken, it was decided to make copper analyses on the milk only in case some of the samples failed to promote erythrocyte

formation and hemoglobin regeneration. Since all of the evaporated milks studied showed hematopoietic properties, copper analyses were not made. However, as our experimental results show that evaporated milk supplemented by iron cures nutritional anemia in rats and that raw milk supplemented by iron does not promote recovery under similar circumstances, we may conclude that there is sufficient copper in evaporated milk, but not in raw milk, to stimulate erythropoiesis and hemoglobin regeneration. This assertion is based upon the observation first made by Hart, Steenbock, Waddell, and Elvehjem (8), and repeatedly confirmed by them and by reports of others including those from our own laboratories (6, 7), that nutritional anemia can be prevented or cured only when copper as well as iron is present in the diet.

SUMMARY

1. Evaporated milk supplemented by iron will cure the nutritional anemia produced by feeding raw milk to albino rats.
2. This action of evaporated milk is ascribed to its copper content.

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THE RELATION OF THE AMINO NITROGEN CONTENT TO QUALITY OF CREAM AND BUTTER*

D. H. JACOBSEN

Dept. of Dairy Husbandry, South Dakota State College, Brookings, South Dakota

The grading or evaluating of the quality of cream for butter-making has been based largely on the acidity and flavor. In some cases the age of the cream has been considered. The classification on the basis of flavor is necessarily very indefinite, and the results of such grading vary with different graders. Age and acidity are important, but wide variations in the flavor and condition of cream may be found at each stage in holding and within each acidity range.

The study of amino nitrogen content was suggested by the fact that the deterioration taking place in cream might be indicated by the presence of amino acids or end products of protein decomposition. Age, acidity and bacterial contamination of cream are recognized as prime factors in causing deterioration, and these same factors operate to increase the rate and extent of protein decomposition. Consequently, a measure of amino nitrogen produced should give some indication of the extent to which such factors have operated. To show whether this deterioration may be measured and correlated with flavor score is the purpose of this study.

A number of investigators have shown that amino acid nitrogen is present in increasing quantities in cream as acidity development progresses.

Ferris (5) studied the soluble nitrogen compounds of cream and butter treated in various ways. He found that proteolysis in cream, as shown by increase in amino acid nitrogen and nitrogen not precipitated by phosphotungstic acid in the corresponding butters begins as soon as the cream develops acidity of 0.2 to 0.3 per cent. Butters held in storage showed an increase in soluble nitrogen compounds, the increase in butters made from sweet cream being slight, while the butters made from the neutralized sour cream showed a somewhat greater increase. The greatest percentage of soluble nitrogen when the butter was fresh, and also the greatest increase during storage, was in butter made from cream which has been allowed to sour before it was pasteurized.

In a later paper Ferris (7) observed that the percentage of the total nitrogen occurring as amino nitrogen and ammonia in first grade cream was generally lower than in the second grade cream. The butters from these grades of cream showed much the same relation. The results ranged from 1.6 to 9.6 per cent on cream of first grade compared to 8.1 to 12.6 per cent on

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second grade cream. The butter from these classes of cream contained 1.6 to 6.3 per cent for first grade and 4.7 to 6.7 per cent for second grade.

That increasing amino nitrogen content in butter is accompanied by lowered score in storage is indicated by Brown (1), Rahn, Brown and Smith (10) Hunziker and Spitzer (9), Brown, Smith and Ruehle (2) and Ferris (5). Although different methods were used by these investigators for determining the degree of proteolysis, their general conclusions were in close agreement.

The decomposition of casein in salted and unsalted milk and butter was studied by Brown (1). The butter was held in storage at 0° C. for 240 days. He found that the casein in both salted and unsalted butter was slowly broken down into amino acids and ammonia. The increase in 20 samples of unsalted butter was from 5.71 per cent to 7.59 per cent while 20 samples of salted butter showed an average increase of from 5.71 per cent to 6.19 per cent. These percentages represent the amino acid and ammonia nitrogen as per cent of the total nitrogen in the butter. Milk to which 5 per cent salt had been added showed significant increases in amino acid and ammonia content over a 7 day period.

The experiments of Rahn, Brown and Smith (10) on the keeping quality of butter showed that an increase in amino nitrogen occurred on all samples during storage. The greatest increase in amino nitrogen was shown in the samples of lowest quality at the end of the storage period. Bacteriological analysis of the butter at intervals during storage showed no apparent correlation with the depreciation in score.

That common off-flavors of butter in cold storage may be caused by protein decomposition was also indicated by Dyer (4). He reported that "common off flavors in cold storage butter may be due to the chemical change expressed through slow oxidation progressing in some one or more of the non-fatty substances occurring in the buttermilk. The extent of such chemical change is directly proportional to the acid present."

Extensive investigations of butter made from pasteurized and unpasteurized cream were reported by Hunziker and Spitzer (9). A chemical study of proteolysis in the butter showed that there was a gradual increase in soluble nitrogen during storage. The increase in soluble proteins was closely related to the quality of the butter as shown by the score when fresh and again after storage for five months. They concluded that protein decomposition was greatest in the raw cream butter.

Brown, Smith and Ruehle (2) showed that the total nitrogen content of butter decreased during storage and that this decrease was accompanied by an increase in soluble nitrogen not precipitated by copper sulphate. The per cent of amino acid and ammonia showed a steady increase on long storage.

Spitzer and coworkers (12) studied the proteolysis of specific organisms in graded cream and concluded that the quality of butter decreased in proportion to the protein hydrolysis. Proteolytic action progressed at a

greater rate in the presence of proteolytic organisms. Salting of butter had no influence in retarding hydrolysis although the growth of micro-organisms was retarded according to this report.

Ruehle (11) reported that the flavor termed metallic was produced by metals, bacteria and amino acids according to experiments in which milk samples were treated with these agents. The amino acids added were those which result on hydrolysis of casein by micro-organisms and enzymes.

The results of these investigations indicate a general relationship between flavor deterioration in cream and butter and the condition with regard to the nitrogenous constituents. This relationship is studied to show what aid in classification or grading may be evolved from the use of amino nitrogen content.

PROCEDURE

The cream used in this study was selected from a number of different sources for the purpose of studying the nitrogen content relationships of cream showing different degrees of deterioration. Churnings were made from cream which was graded as second or undergrade, first grade sour and fresh sweet cream. An effort was made to obtain a representative market range of butter scores.

All cream was pasteurized by heating to 62.5° C. and holding at this temperature for thirty minutes. Churnings with acidities above .25 per cent were neutralized to .23 per cent and no starter was used. The churning was carried on in a Cherry churn of 400 pounds capacity. The butter was salted at the rate of two per cent in the finished butter and moisture content was limited to sixteen per cent.

Samples of the cream, buttermilk and butter were taken at churning time for amino nitrogen analysis. From each churning two ten-pound tubs of butter were saved; one of which was held in the local cold storage rooms and the other was shipped to a Federal-State butter grader* for scoring. The butter stored locally was sampled at the end of one, three and six-month storage periods for the amino nitrogen analysis.

The sample tubs were scored when fresh and after three and six months storage at 0° C. These scores were then used in classifying the butters for the comparison of the amino nitrogen contents with butter scores.

CHEMICAL ANALYSIS

Total nitrogen in cream and buttermilk was determined on 5 gram samples by the Kjeldahl method. Total nitrogen in butter was determined on 50 grams of butter after the fat had been extracted with petroleum ether. It was found that a fairly complete removal of fat from the butter sample was necessary before digestion could be carried on successfully.

* The butter was stored by the Land O Lakes Creamery, in Minneapolis, Minn., and scored by Mr. C. W. Fryhofer.

Amino nitrogen was determined by the Sorensen formol titration and the Van Slyke Nitrometer methods. The amino nitrogen values used for comparison with butter flavor were obtained by the Sorensen method. A comparison of the two methods of analysis for amino nitrogen in the cream, buttermilk and butter is presented in part II.

The Sorensen method for amino nitrogen was applied on butter using duplicate 50 gram weighed samples. An equal volume of warm distilled water (approx. 110° F.) was added to each sample and the entire charge titrated with N/20 sodium hydroxide allowing time for the aqueous and fat layers to separate so that the color developed in the aqueous layer could be noted. Amino nitrogen in cream, buttermilk and butter was determined by the Van Slyke Method as described in A. O. A. C. Methods of Analysis, second edition, 1925. The samples were prepared for analysis according to the method of Ferris (5). The determination of amino nitrogen in butter by the Van Slyke method was not entirely satisfactory because of the low concentration of amino nitrogen making the percentage error too great. Sufficient difference between samples was indicated, however, and definite trends were shown by the results.

The Sorensen method was slightly modified by the use of N/20 sodium hydroxide instead of barium hydroxide as the titrating agent. Otherwise the method followed was the tentative method described in A. O. A. C. Methods of Analysis, 2nd edition (1925). The cream and buttermilk samples for analysis consisted of 20 grams weighed in duplicate into Erlenmeyer flasks and diluted with equal volumes of distilled water to aid in titration. This dilution aided materially in showing a sharper end point in the titration.

EXPERIMENTAL RESULTS

Part I

Although it is recognized that any classification made on the basis of cream grade or butter score is not entirely satisfactory, it was used because it is the method of classification employed for these products in the trade.

The values recorded as amino nitrogen in this work refer to the nitrogenous products commonly referred to as amino acid and ammonia nitrogen. The designation "amino nitrogen" is used throughout for the sake of brevity.

The twenty-seven churnings studied have been arranged in various ways for the purpose of showing the relationships which exist between amino nitrogen content and quality of cream and butter.

Table 1 presents the flavor and acidity and amino nitrogen content of cream and the flavor criticism, flavor score and amino nitrogen content of butters made from this cream. The butter flavor scores and criticisms were made within 7 days after churning by the federal-state butter grader. The cream

was graded and criticized by the author at the time of churning. In general, it may be noted that cream of low acidity showed a low percentage of amino nitrogen and produced butter of a high flavor score. Conversely, the high acid cream showed higher amino nitrogen content and lower butter score. Exceptions, however, will be noted such as churnings 20 and 24 where feed flavors were responsible for the low butter flavor scores received.

It is of interest to note that the churnings termed stale generally showed relatively higher amino nitrogen content. The same relationship may be noted in the butter.

The apparent lack of agreement between the amino nitrogen values for cream and butter of the same churning may be explained by the fact that washing of the butter in the churning process may have removed certain types of nitrogenous constituents. The nitrogenous products present in the cream no doubt were transferred to the butter in varying proportions accord-

TABLE 1
Amino nitrogen content and quality of cream and butter

Churn No.	CREAM		BUTTER			
	Acidity Per cent	Flavor Criticism	Amino* Nitrogen	Amino* Nitrogen	Flavor Score	Flavor Criticism
1	.40	Clean sour	4.90	4.42	36	Sl. old cream
2	.48	Clean sour	5.40	5.13	35	Sl. alkaline
3	.40	Clean sour	5.71	4.21	36	Sl. old cream
4	.48	Sour, slightly fermented	5.76	5.92	35	Sl. bitter
5	.16	Sweet, fairly clean	4.28	6.02	35	Sl. bitter
6	.54	Clean sour	4.81	5.76	36	Heated
7	.46	Clean sour	5.76	4.83	36	Sl. old cream
8	.55	Slightly stale, rancid	5.84	6.44	34	Unclean
9	.40	Sour old cream	5.63	6.55	35	Old cream
10	.76	High acid, stale, putrid	9.94	7.54	31	Very rank, metallic
11	.62	“ “ stale, metallic	6.36	8.22	32	Stale metallic
12	.54	“ “ stale	6.19	6.00	34	Kerosene taint
13	.19	Sweet clean	4.63	4.73	37	Clean
14	.46	Clean sour	4.31	5.10	35	Old cream
15	.17	Sweet clean	5.22	4.45	36	Weedy
16	.58	Sour, stale, oily	5.76	7.89	34	Metallic
17	.70	High acid, stale, oily	6.51	6.52	33	Unclean, sl. cheesy
18	.71	“ “ cheesy	7.03	6.22	32	Very stale, oily
19	.14	Sweet clean	5.18	5.39	36	Sl. unclean
20	.20	Low acid, feed	5.18	8.56	34	Stale, alkaline
21	.72	High acid, stale	6.20	7.91	33	Stale cream
22	.72	“ “ “	6.47	6.79	32	Very stale cream
23	.83	“ “ oily	6.30	7.09	32	Very stale alkaline
24	.20	Stale feed	6.08	8.55	31	Barny, stale, v. unclean
25	.29	Weedy, bitter	4.67	6.66	33	Very unclean, barny
26	.16	Sweet clean	4.59	3.87	38	Clean
27	.16	Sweet clean	5.13	5.65	37	Coarse salt

* Determined by the Sorensen titration method and expressed as percentage of total nitrogen.

ing to the form in which they were present and to the thoroughness with which washing was carried out.

AMINO NITROGEN CONTENT AND CREAM GRADE

In Table 2 the churnings were classified according to the flavor and acidity of the cream. The butter resulting from the cream in these three grades ranged in flavor score as follows: I, 36 to 38; II, 34 to 36, and III, 31 to 34.

The average amino nitrogen content showed an increase from one grade to the next, but the difference was not great enough to be of significance for grading. It may be noted that cream of low acidity without stale flavor showed low amino nitrogen content, while cream of stale flavor regardless of acidity showed high amino nitrogen content. This may indicate that the flavor commonly termed stale may be caused by increased amino nitrogen content in the cream.

The wide variation in the amino nitrogen content of churnings within each grade, however, makes definite conclusions impossible. Although the lower flavor grades in general showed a higher percentage of amino nitrogen, there were exceptions to this rule. For instance, churning 25 showed a low percentage of amino nitrogen and was placed in grade III because of a feed flavor.

TABLE 2
Amino nitrogen content of cream of three grades

GRADE	NUMBER CHURN- INGS	DESCRIPTION	AVERAGE AMINO NITROGEN*		AVERAGE BUTTER FLAVOR SCORE
			Cream	Butter	
I	5	Sweet, clean, below .20% Acidity	4.82	4.95	36.8
II	10	Slightly off-flavored, be- low .60% Acidity	5.17	5.65	35.3
III	12	Marked off-flavored, above .60% Acidity or both	6.45	7.15	32.6

* Determined by the Sorensen titration method and expressed as percentage of total nitrogen.

The data on amino nitrogen content of cream and butter agree in a general way with the figures given by Ferris (7) who studied the amino nitrogen and ammonia content of first and second grade cream and butter. His work showed "first" grade cream with a range from 1.6 to 9.6 per cent and "second" grade with a range of 8.1 to 12.6 per cent. The classification used in the present work includes an intermediate grade. The range, however, for the three grades as found in Table 3 was I—(4.59 to 5.22), II—(4.28 to 5.76), and III—(4.67 to 9.94), making a range of 4.28 to 9.94 for all churnings. The absence of the extremely high and low values, however, may be

explained by the fact that a limited number of churnings are included in this work.

Butter made from the "first" grade cream according to Ferris (7) ranged from 1.6 to 6.3 per cent amino nitrogen while "second" grade showed 4.6 to 6.7 per cent. The present work failed to show churnings below 3.87 and ranged upward to 8.56 per cent.

RELATIONSHIP OF BUTTER FLAVOR GRADE TO THE AMINO NITROGEN
CONTENT OF CREAM, BUTTERMILK AND BUTTER

In Table 3 the churnings are divided into three grades on the basis of flavor score as follows: Grade I, 36 or above; Grade II, 34 to 36, and Grade III, below 34. A comparison is presented of the average flavor score in each grade with the amino nitrogen content of the cream, butter and buttermilk.

TABLE 3
Amino nitrogen in cream, buttermilk, and butter

GRADE	NUMBER CHURN- INGS	FLAVOR SCORE ON BUT- TER	PER CENT AMINO NITROGEN*					
			Cream		Buttermilk		Butter	
			Aver- age	Range	Aver- age	Range	Aver- age	Range
I	11	36.36	5.09	(4.28-5.76)	5.44	(4.71-6.14)	5.02	(3.87-6.02)
II	7	34.43	5.47	(4.31-6.19)	5.82	(4.80-7.84)	6.85	(5.10-8.56)
III	9	32.11	6.62	(4.67-9.94)	6.54	(4.88-8.53)	7.08	(4.86-8.55)

* Determined by Sorensen method and expressed as percentage of the total nitrogen.

The amino nitrogen values in the arbitrary grades set up increased from the first to the third grade, but the difference between grades was not great. The range of values in each class was too wide to allow definite conclusions in regard to the utility of amino nitrogen values for grading cream. Considerable overlapping of the three grades was shown when the amino nitrogen values were compared. Similar overlapping was shown by the values obtained for the buttermilk and butter. The samples in which low amino nitrogen values were accompanied by low scores in most cases exhibited off-flavors which could not be traced to protein decomposition.

AMINO NITROGEN CONTENT AND FLAVOR SCORE OF BUTTER

A general relationship between cream grade and amino nitrogen content was shown in Table 2, when cream was classified according to its acidity and flavor. The difference in amino nitrogen content of the three grades suggested that a division of churnings on the basis of amino nitrogen content of the cream might give additional information. Such an arrangement is shown in Table 4.

TABLE 4

Butter flavor score resulting from cream of three grades based on amino nitrogen content

PER CENT AMINO* NITROGEN	NUMBER OF CHURNINGS	BUTTER FLAVOR AVERAGE	FLAVOR SCORE RANGE
Less than 5%	7	35.9	33-38
5 to 6%	12	35.3	34-37
Over 6%	8	32.2	31-34

* Determined by Sorensen method and expressed as percentage of the total nitrogen.

Cream containing more than six per cent of the total nitrogen as amino nitrogen made butter of significantly lower flavor score. Cream of lower amino nitrogen content showed considerable variation.

The narrow range of values for amino nitrogen made classification difficult. The range for 27 churnings was 4.28 to 9.94 per cent as shown in Table 1. It will be noted that off-flavors apparently not related to protein decomposition caused the low score in some cases. The churning 24 for instance received the lowest flavor score and was made from sweet or low acid cream. This cream was described as having a stale, feed flavor.

CHANGES IN AMINO NITROGEN CONTENT OF BUTTER IN STORAGE

A number of investigators have indicated that there is a gradual increase in amino nitrogen content of butter in storage. The data reported in Table 5 bear out this conclusion and in addition show the rate of change in three grades of butter. This butter was held in storage at 0° C. and showed marked deterioration by the end of three months of the storage period.

TABLE 5

Increase in average amino nitrogen compared with average loss in flavor Score of three classes in storage*

GRADE	NUMBER OF CHURN- INGS	FRESH		3 MONTHS		6 MONTHS	
		Flavor score	Amino nitrogen	Flavor score	Amino nitrogen	Flavor score	Amino nitrogen
I	11	36.36	5.02	35.45	7.26	35.41	8.65
II ..	7	34.43	6.85	34.08	8.19	34.57	9.27
III	9	32.11	7.08	31.44	8.59	31.00	9.60

* Determined by Sorensen titration method and expressed as percentage of total nitrogen.

The amino nitrogen values of the three classes of butter maintained the same general relationship to each other throughout the storage period. The difference between classes, however, became smaller as the storage period advanced.

There appears to be no direct correlation between the increase in amino nitrogen and loss in flavor score on storage. In fact, a slight improvement

in average score of butters in Class II was accompanied by a significant increase in amino nitrogen. It will be noted, however, that at each storage interval the lowest score is associated with the highest amino nitrogen content.

The greatest increase in amino nitrogen was recorded in the highest grade butter, which was made largely from cream of low acidity. This is not in agreement with Ferris (6) who found that the increase in soluble nitrogen compounds was somewhat greater for the sour cream butter. The highest per cent of amino nitrogen, however, was found in the lowest grade butter when fresh and at each stage of the storage period.

Part II

COMPARISON OF SORENSON AND VAN SLYKE METHODS FOR AMINO NITROGEN IN CREAM, BUTTERMILK AND BUTTER

The amino nitrogen values in the preceding tables were determined by the Sorensen titration. In Table 6 a comparison of the results of Sorensen and Van Slyke methods on the same samples is presented. The percentages reported are based on the total nitrogen content.

The range of values for total nitrogen was as follows:

Cream	294 to 425.6	mgm. in 100	grams
Buttermilk	333 to 594	" " "	" "
Butter	43 to 72	" " "	" "

The above figures compare closely with those previously reported for these products.

According to Brown (3) the nitrogenous compounds titrated in the Sorensen formol titration are ammonia, primary amines and amino groups of amino acids and polypeptids which react with formaldehyde. The titration therefore represents the sum of these substances. The Van Slyke method, on the other hand, measures only the nitrogenous compounds from which nitrogen gas can be liberated through the nitrous acid reaction. These nitrogenous compounds are largely mono-amino acids and ammonia. It is evident that some difference between the values obtained by the Sorensen and Van Slyke methods might be expected. The following table and Figure present a comparison of the results on cream, buttermilk and butter.

The total nitrogen values in the three grades of cream and buttermilk were quite similar when averages were compared. Although the total nitrogen in buttermilk ranged considerably higher than in cream, the distribution of amino nitrogen compared closely in the two products.

Table 6 shows somewhat higher results in classes I and II for the Sorensen titration. In these classes the protein decomposition had not progressed as far as in class III. Class III included churnings which showed definite signs of age and staleness. One might conclude that the close agree-

TABLE 6
Comparison of Sorensen and Van Slyke methods for amino nitrogen in cream and buttermilk

GRADE	NUMBER OF CHURNINGS	CREAM			BUTTERMILK		
		Total N Mgm. in 100 gms.	Amino N*		Total N Mgm. in 100 gms.	Amino N*	
			Sorensen	Van Slyke		Sorensen	Van Slyke
I	11	334.2	5.09	4.38	482.2	5.44	4.65
II	7	342.9	5.47	5.33	460.9	5.82	5.71
III	9	314.3	6.62	6.50	435.2	6.54	6.57

* Expressed as percentage of total nitrogen.

ment of results in class III existed because the two methods measured the end products of protein decomposition, *i.e.*, amino acids and ammonia with the same degree of accuracy. In the better grade cream in the classes I and II, the protein decomposition had not reached this stage and the same nitrogenous products were not determined by both methods. These conclusions are substantiated further in the comparison presented in Figure 1.

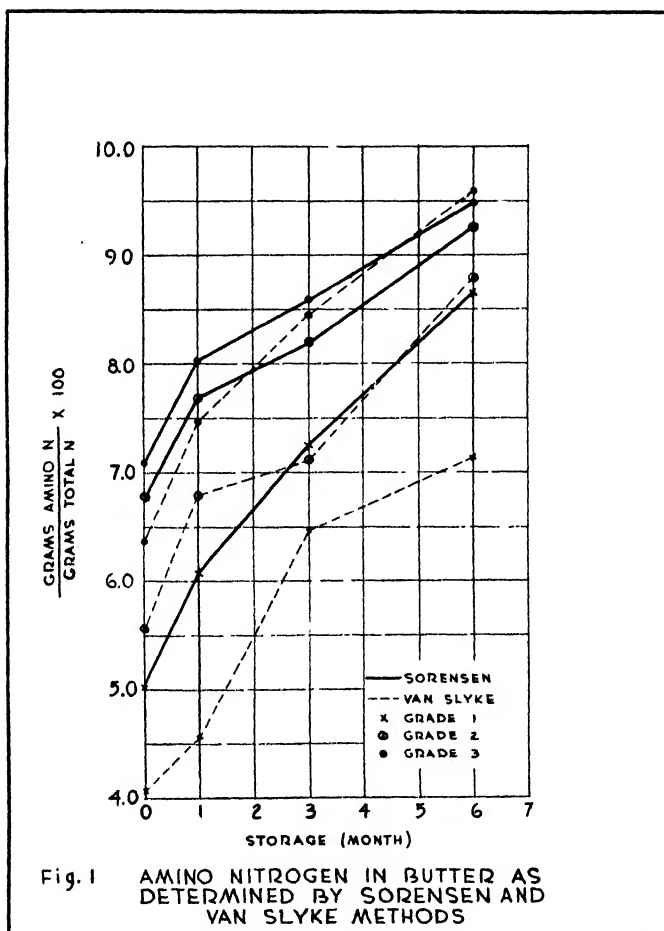
In a comparison of the Sorensen and Van Slyke methods (Figure 1) the Sorensen titration gave the highest results in all cases except one. These figures are based on averages in the three grades of butter. However, the relationship holds true on individual samples. Neither method gave results which showed sufficient difference between the three grades of butter to be of great significance for grading. The Van Slyke method, however, indicated somewhat more difference between grades than did the titration method. The results would indicate that the Van Slyke method differentiated between amino acid nitrogen and other protein degradation products to a finer degree than the Sorensen titration method. The difference between the values obtained by the two methods was greater on the higher classes of butter. In this butter the decomposition products which react in the Sorensen method were probably present in a greater proportion than in the lower grades.

In Class III after 6 months storage the average per cent amino nitrogen by the Sorensen method was slightly lower than the result by the Van Slyke method. This apparent exception to the rule bears out a conclusion previously cited, that the samples showing the more advanced stages of protein decomposition tended to give more nearly the same values by both methods.

SUMMARY

Part I

The amino nitrogen content of cream and butter was compared with the type of flavor and flavor score of butter in twenty-seven churnings. The butter was held at 0°C. and amino nitrogen analysis made on the butter when fresh and after one, three and six months in storage.



When the twenty-seven churnings were graded according to the flavor and acidity of cream, the per cent of the total nitrogen occurring as amino nitrogen increased as the quality of cream decreased.

Although there were a few exceptions, in general, the cream and butter containing the higher per cent of amino nitrogen showed the lower butter scores. Classifications of churnings on the basis of amino nitrogen content of cream alone, however, failed to divide the churnings into satisfactory butter flavor grades.

When the churnings were classified according to the butter flavor score received on the market, some definite trends were shown. The highest percentage of total nitrogen occurring as amino nitrogen was found in the low-

est score butter both when fresh and at each stage of the storage period up to six months. From these results it appears that amino nitrogen content may be of aid in cream grading but only when used in combination with other tests such as flavor and acidity.

Part II

The amino nitrogen content as determined by the Van Slyke method was usually lower than that determined by the Sorensen method, but the general relationship between values was the same on each series of samples.

Closer agreement between values obtained by the two methods was obtained on butter samples which had undergone considerable deterioration in storage than on freshly made butter.

The Sorensen titration method is easier to apply than the Van Slyke method when the small quantities of amino nitrogen in butter filtrates are considered.

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MOLASSES HAY SILAGE

C. B. BENDER, H. H. TUCKER, W. C. KRUEGER, K. O. PFAU, AND A. S. FOX

New Jersey Agricultural Experiment Station, New Brunswick

The question of the preservation of fodder for farm animals possesses both a scientific and practical significance. It is obvious that the food requirements and the factors modifying them are of vital importance to the dairy industry. Any method which tends to improve the quality of the feed without raising impossible barriers, such as initial cost of installing, or high technical ability of the operator, for its general acceptance, will find its place on the dairy farm.

Fodder for winter feeding is of two classes, namely; dried, which includes the hay from grasses and legumes; and succulent, which is mostly corn silage.

The haying process has always been dependent on the weather conditions for proper curing. Properly cured it is an excellent feed and there is not a great loss in nutrients. Under adverse conditions, which necessitate considerable manipulation of the cut material before it is completely dry, losses in nutrients occur due to leaching and shattering of leaves.

In order to overcome these losses, methods of artificially drying hay have been developed. These methods turn out an excellent product which retains the green color of the grass as well as practically all of the nutrients. The disadvantage of these methods is the cost of installing the driers and the large volume of material to be dehydrated in order to produce it economically.

The other method of preserving roughages seemed to hold more promise in the solution of this problem. The ensiling process is not a new one in this country. Since 1873 when the first silo was built in Illinois (3), the ensiling of corn has increased to the point where a large percentage of the dairymen are using the method.

The ensiling process in brief is brought about by enzymes, bacteria and yeasts when green forage is firmly packed to exclude air. These agents break down most of the sugars into chiefly lactic and acetic acids. After a pH of 3.5-4.0 is reached the accumulation of acid checks the action of bacteria and enzymes.

The ensiling of soybeans, sweet clover and alfalfa has been tried in this country with more or less success. It has not been accepted as a general practice because of spoilage. Aldershaw (2) and Whittet (6) maintain this

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spoilage in most cases is due to the low sugar content, maturity and lack of moisture in the material.

The ensiling of grass in pits or towers has been a successful practice in European countries for years where no corn can be grown. According to Watson (5), Aldershaw (2) and Whittet (6), the method is popular in Europe. However, it has not been adopted in this country because of the time and labor involved in the method. The stacking of the green material, tramping it by horse, mule or man power and then covering smaller stacks with earth to prevent oxidation does not appeal to the American farmer. Although the material keeps well, there is quite a loss in nutrients.

The A. I. V. method of ensiling grasses and legumes, a patented process developed by Arthur I. Virtanen (4) was presented at the meeting of the Co-operative Butter Export Association Valio in 1929. This method is founded on the principle "that the detrimental decomposition processes in the fodder, above all the respiration of the plant cells, the breakdown of proteins and harmful fermentation such as those caused by coli bacteria and butyric acid bacilli are prevented by the addition to the fodder, at the time of ensiling, the requisite amount of acid which will raise the acidity of the mass to a point between pH 3 and pH 4." This acid preservation of green plant tissue in its natural state is brought about by highly ionized mineral acids. Wilson *et al.* (7) say "that the mixture of 2N hydrochloric and sulfuric acid has been found to be most satisfactory for this purpose. The quantity of acid varies with the species of crop, the state of maturity and the soil reaction, and must be determined for each crop." Results at the Walker-Gordon Laboratories at Plainsboro, N. J., showed that an average of 9.5 gallons of 2N acid were sprayed per 1000 pounds of green alfalfa and six gallons per 1000 pounds of green corn.

The methods cited are of value under certain conditions but they do not lend themselves to general adoption by the dairymen as a whole either because of the cost of installation or technical ability necessary for the operation.

Because of these facts this Station instituted experimental work in 1931 to test the keeping qualities of sweet clover by ensiling it with molasses. Molasses was added to raise the carbohydrate level of the material for bacterial action. This material kept well and no difficulty was experienced in feeding it.

As the result of this preliminary work, a comprehensive experiment was instituted in 1934 to study this problem from the following points:

1. To develop a practical method of ensiling grasses and legumes without too much loss in nutrients.
2. To study temperatures developed by the ensiling process when processing green material of high and low moisture content with molasses.

PROCEDURE

The green material used in this experiment varied from good alfalfa to mixed grasses. It was mowed and ensiled from October 2-9 inclusive. The material when ensiled was divided into two sections according to its moisture content.

The high moisture grass was mowed and hauled to the silo within one to six hours from the time it was cut. The range in moisture was from 60 to 75 per cent.

The low moisture grass was allowed to lay in the field from 12 to 24 hours before ensiling. This material ranged from 23 to 55 per cent moisture.

All moisture determinations were made on composite samples of each load by means of a Brown-Duvel Tester.

All the grass was cut with a tractor mower, raked into windrows with a side delivery rake and loaded on a truck with a hay loader. Every load was weighed as it came from the field in order to determine the exact amount of molasses to incorporate. The grass was chopped and blown into the silo by a * "Hay Chopper Silo Filler."

Molasses was added at the rate of forty pounds per ton of grass irrespective of the moisture content. The molasses was diluted as follows: 40 pounds of molasses were put into a 40 quart milk can and the remainder of the can was filled with water. The resulting mixture contained 1 pound of molasses per quart, or 4 pounds per gallon. This mixture poured very readily and gave sufficient bulk so that the molasses could be measured very easily and distributed evenly through the grass. This molasses mixture was placed in a tank high enough above the blower so that the solution would run into the blower pipe just above the blower outlet. The exact amount of molasses mixture for each load was placed into the tank and the flow regulated by a valve to give as uniform a flow as possible while the grass was being chopped.

Fifteen loads, or 59,080 pounds of high moisture grass were ensiled on October 2 and 3. This was put in on top of corn silage which had not been fed out of the silo, as shown in Diagram I. Thirteen loads or 32,395 pounds of low moisture grass were ensiled from October 4 to October 9. This was placed on top of the high moisture section. All details of weights and moisture at the time of ensiling will be found in Table 1.

Since the molasses was added at the rate of 40 pounds per ton of green grass regardless of moisture content, there was nearly twice as much molasses added per ton of dry matter in the high moisture section as there was in the low moisture section. The ratios of molasses to dry matter were: 1:16.6 in the high moisture section and 1:27.4 in the low moisture section.

All of the data on these two sections are found in Figure I and Table 1.

The silage was not packed but was leveled off when it was necessary to place thermocouples.

* Papec Hay Chopper Silo Filler. Loaned by Papec Machine Co., Shortsville, N. Y.

TABLE 1
Summary of high and low moisture grasses at time of ensiling

ITEM	HIGH MOISTURE GRASS	LOW MOISTURE GRASS
1. Weight of Grass from Field	59,080.0	32,395.0
2. Range of Moisture Content in Loads	60-75%	23-55%
3. Pounds of Dry Matter in Grass	19,593.7	18,006.8
4. Pounds of Moisture in Grass	39,486.3	14,388.2
5. Average Moisture Content of Grass	66.83%	44.41%
6. Pounds of Molasses Added Per Ton	40	40
7. Pounds Molasses per Ton of Dry Matter in Grass	120.44	72.86

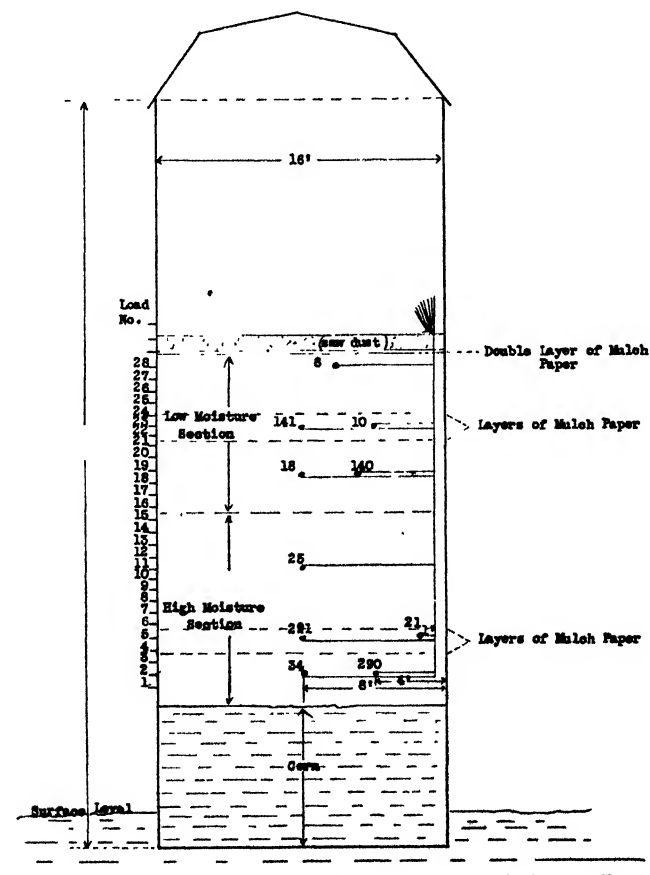


FIGURE I
Placement of Thermocouples.

PLACEMENT OF THERMOCOUPLES FOR MEASUREMENT OF TEMPERATURES

In order to study the temperatures developed during the ensiling process ten thermocouples were placed in the material at various levels and distances from the side wall, (see Figure 1) while the silo was being filled. Previous to placing each thermocouple the green material was leveled off. All of the wires were led to the inside of the wall of the silo, grouped and brought to the surface.

In the center of both the high and low moisture section as can be seen on Figure 1, layers of mulch paper separated loads 4 and 5 and 21 and 22 for sampling.

After filling was completed the top was covered with mulch paper and five inches of sawdust. Waste material and cleanings consisting of chopped corn stalks and grass were put on top of the sawdust adding another two inches. A dairy thermometer was then placed one foot from the surface and the temperature recorded.

Temperature readings were taken by a galvanometer hooked up to the lead wires from the thermocouples. From October 4-22, temperature readings were taken twice a day. From then until March 10 readings were taken at longer intervals.

RESULTS

On February 11 the silo was opened with the following results: The first six inches removed were very wet while the next six inches were dry and moldy. Below this very little of the silage was fit to feed until the high moisture material was reached. A three foot band extending from the wall of the silo was very dry and somewhat moldy. The center was very brown in color. The lower sections of the low moisture section were black and charred. The maximum temperatures here had reached 160° F. As a whole the low moisture section which reached a maximum temperature of 160° F. was unfit for feeding.

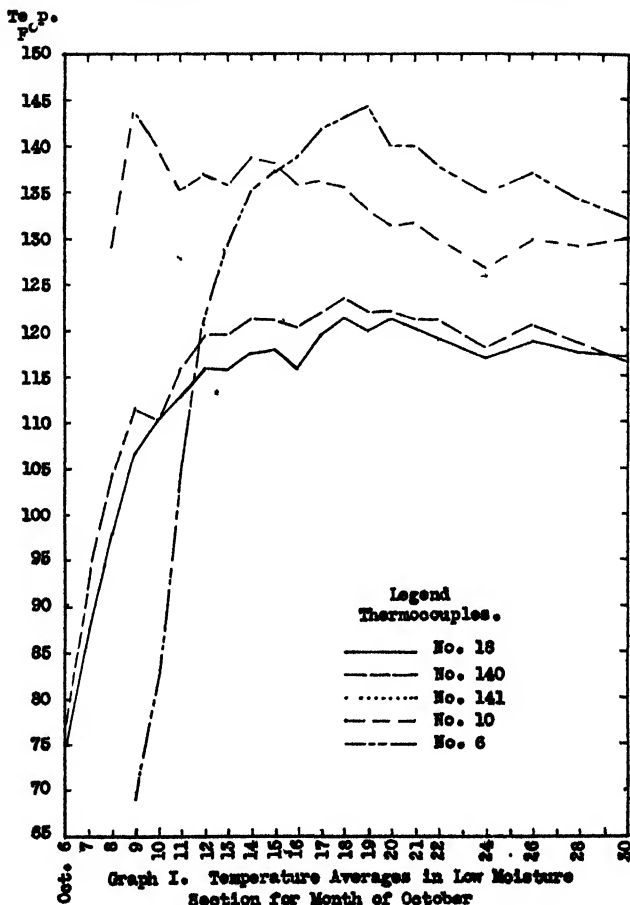
When the high moisture level was reached below the fifteenth load as shown on Figure I, the picture changed. Practically all of the silage with the exception of a few moldy lumps in the upper layer was in excellent condition. It was of good odor, quite green, succulent and no indications of burning or rotting. The maximum temperature reached in the upper part of this material was 122° F. (probably due to its close proximity to the low moisture section) while the lower levels rarely exceeded 100° F.

*Bacterial analyses of samples taken from loads 21 and 22 between the layers of mulch paper in the low moisture level (see Figure I) showed a moisture level of 45.8 per cent with 30,000 bacteria per gram on a moist basis. The sample taken of load 4 and 5 at the high moisture level contained 59.5 per cent moisture with 1,200,000 bacteria per gram on a wet basis.

* J. H. Anderson, Department of Bacteriology.

†Chemical analyses of three samples at the high moisture level showed:

Water	66.43
Protein	3.73
Fat	1.24
Fiber	7.39
N. F. E.	17.86
Ash	3.35
**Carotene	0.0026



The carotene content of the grass silage was higher than our corn silage which ran 0.0018%. Our machine dried timothy contained 0.0045% and the dehydrated alfalfa contained 0.0079%. By converting the dehydrated

** M. W. Taylor, Department of Biochemistry.

† Chas. A. Cathcart, State Chemist.

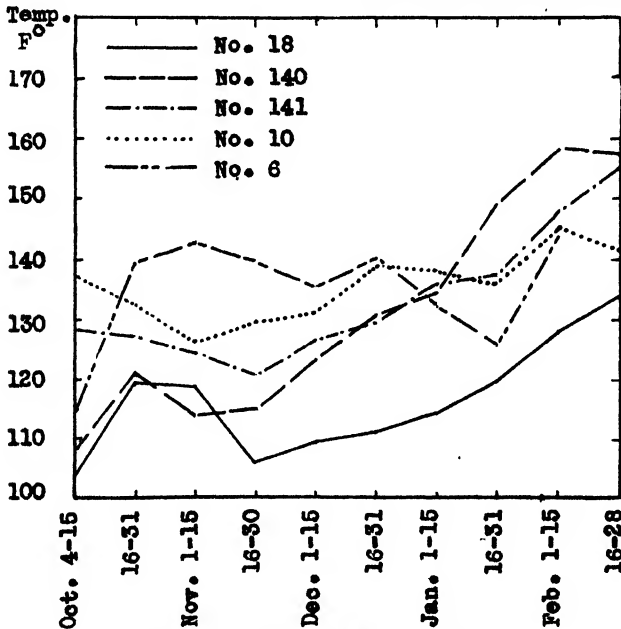
alfalfa and timothy back to a green basis, it can be seen that ensiling does not reduce the carotene content of the material any more than the dehydration process.

The analyses of the low moisture silage were discarded because of the spoiled condition of the material.

DISCUSSION OF RESULTS

Graph I shows the average of the two daily readings for each of the thermocouples in the low moisture section up to October 30. By the fifth day the temperature of each thermocouple was about 100° F. and after the seventh day ranged from 115° F. to 144° F. All showed some tendency to drop by October 30 but they were still very high.

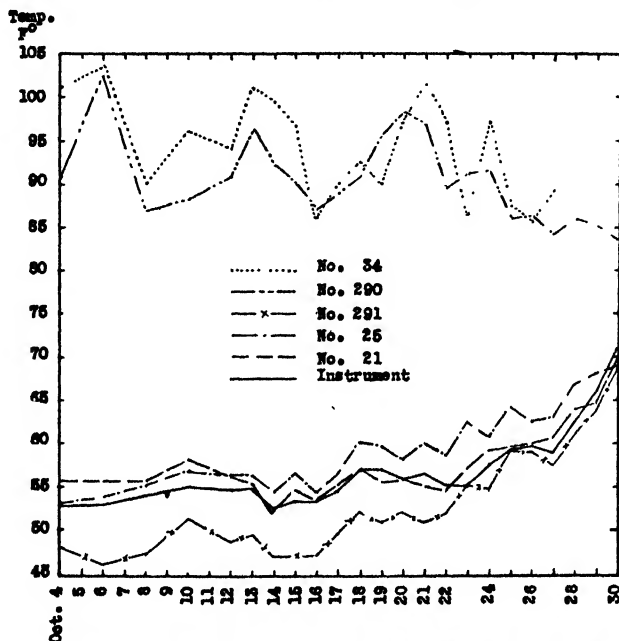
On Graph II will be found fifteen day averages of the temperatures of



Graph II. Fifteen Day Temperature.
Averages in Low Moisture Section.

the five thermocouples in the low moisture section. It is apparent that during November the temperatures dropped slightly, but from then until March 1 showed a fairly regular increase. During the entire period, the temperatures ranged from 104° F. to 157.7° F. Omitting thermocouple Number 18 which was closest to the high moisture section, we find the temperatures were practically always above 120° F. Even Number 18 reached 130° F. at the end.

The temperatures in the high moisture section as a whole, were well under 100° F. Thermocouple Number 25 was the only one above 100° F. up to October 20 and Numbers 34 and 291 went up to 103° F. from November 1 to 15. Graph III presents the average of the daily temperature readings

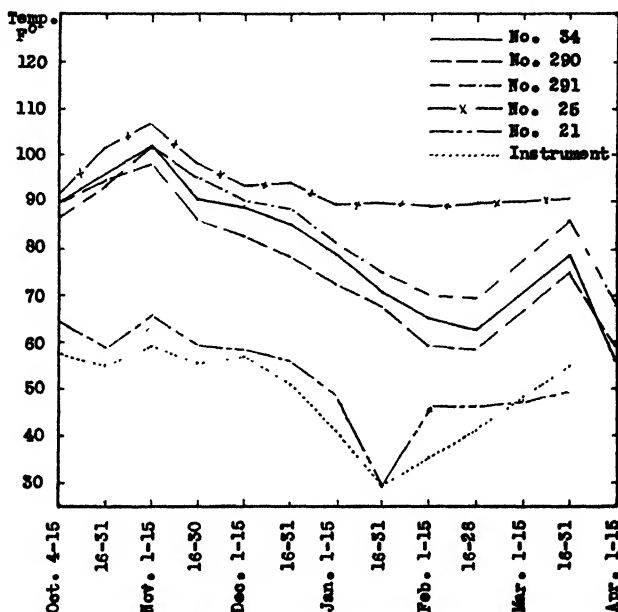


Graph III Temperature Averages in High Moisture Sections for Month of October

in the high moisture section to October 30. Number 25, which was nearest to the low moisture section was the highest. The variation in temperature to October 30 between numbers 34, 290 and 291 was from 1° to 10°. This shows a very uniform temperature each day in the several points of the high moisture section where the best silage was found. It is also interesting to note that the lowest temperatures were in the center or four feet from the silo wall.

Thermocouple Number 21 was placed one foot from the silo wall, but was probably moved almost to the wall due to the settling of the silage. Its temperature ranged from 47.5° to 68° F. while the temperature of the instrument ranged from 46° to 64° F. The temperature of the instrument was slightly higher than the outside temperature. This closeness of temperatures between the instrument and Number 21 indicates that the silage near the silo wall is influenced very markedly by the outside temperature. These figures are shown in Graph I.

Temperatures for the high moisture section have been averaged for 15 day periods and are shown in Graph IV. This graph shows temperatures



Graph IV Fifteen Day Temperature Averages in High Moisture Section

from October 4 to April 15. The temperature of Number 21 was only slightly above that of the instrument until after March. This condition changed slightly with the coming of warmer weather. The temperatures did not vary to any great degree even at that time. The temperatures of the other four thermocouples ranged from 56.5° F. to 109.0° F. Up until January 15 they did not go below 70° F. which would indicate a favorable temperature for the growth of fermentation bacteria during the first three months of ensiling.

Dr. Anderson's report on the bacterial content states "Undoubtedly the low moisture contents and subsequent high temperatures are accountable for the low bacterial counts in the low moisture silage. Not only were the bacterial numbers too low to be of significance, but the kinds present were not typical of fermented silage. They more closely resemble types one would expect to find on partially dried grasses." This high temperature no doubt, would destroy most of the bacteria of the lactic acid type. This is based on the report of Dr. Kirsch (1) that the proper temperature for the growth of the lactic acid bacteria would suppress micro organisms such as the butyric acid type.

CONCLUSIONS

(1) Ensiling of green grasses and legumes of high moisture content with forty pounds of molasses per ton will produce a good palatable silage.

(2) Charring in the low moisture silage is brought about by oxidation which causes an increase in temperature up to 160° F. This temperature destroys the lactic acid type of organism.

(3) Ensiling of partially dried grass with molasses, unless it be put in the silo first where leachings from the greener material and consequent greater pressure will preserve it, is not to be recommended.

(4) As a result of the temperatures developed during the ensiling process, it is suggested that the silo should not be opened for feeding until it has processed for eight weeks.

(5) The ensiling of high moisture grasses and legumes with molasses results in a very small loss in nutrients.

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THE DECREASE IN THE LACTOSE CONTENT OF MILK FOLLOWING THE PRODUCTION OF ARTIFICIAL HYPOGLUCEMIA*

W. R. BROWN,¹ W. E. PETERSEN² AND R. A. GORTNER¹

INTRODUCTION

In the preliminary studies with normal cows it was found to be difficult to demonstrate clearly the relationship existing between the blood sugar and the lactose. It was, therefore, decided to investigate the possible advantages to be gained by the use of insulin in the investigation.

HISTORICAL

When Paton and Cathcart (10) artificially depleted the blood sugar of goats by the use of phloridzin, the milk output and the lactose content were both decreased.

Guisti and Rietti (6) injected insulin into goats but found no difference in the quality of the milk during the first twenty-four hours; however, on the second day they recorded a hypoglycemia accompanied by a diminution in the amount of milk secreted, and a decrease of from 7 to 4 per cent in the lactose content. On the other hand Nitzescu and Nicoleau (9) injecting insulin subcutaneously into two ewes found no difference in the milk yield of one animal and but slight decrease in the yield of the other. They report that the lactose usually decreased after an insulin injection, but that it was but slight even when the hypoglycemia was considerable. However, lowered percentages of lactose were still obtained even when the blood glucose had returned to normal. A more marked effect was obtained by Bucciardì (2) after the subcutaneous injection of twenty units of insulin into ewes. Milking twice daily, Bucciardì obtained a decrease in the lactose output of from 25 to 75 per cent during the day of injection, but on the day following injection the lactose output returned to normal. Five to eight successive insulin injections were found to cause a cessation of lactation. As the lactose varied with the blood sugar, Bucciardì concluded glucose to be the precursor of the glucose portion of the lactose. Macchiarulo (8), a student of Foa, injected 30 units of insulin subcutaneously into goats. He demonstrated a reduced blood sugar of from .090 to .040 per cent and a reduced lactose percentage in the secreted milk of from 4.3 to 3.8 per cent.

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* The data in this paper are taken mainly from a thesis presented by W. R. Brown in partial fulfillment for the Ph.D. degree and published with the approval of the Director as Paper No. 1381.

¹ From the Division of Agricultural Biochemistry, University of Minnesota.

² From the Division of Dairy Husbandry, University of Minnesota.

THE PROBLEM

Very little experimental evidence has been obtained as to the effect of the insulin upon the lactose content of the milk. Only small amounts of insulin have been injected, subcutaneously, into sheep and goats, and the work reported does not appear to have been very well controlled.

In no case had the effect of insulin upon the lactose of the bovine been studied. It was, therefore, thought that intravenous injections of large quantities of insulin into milking cows might yield more positive evidence than that already obtained, that glucose is actually the direct precursor of lactose. It was expected that a sudden pronounced artificially-produced hypoglucemia would result in a sudden marked decreased lactose elaboration, so, using the bovine as the experimental animal, the following insulin injections were carried out.

EXPERIMENTAL

In the studies of the Italian workers previously mentioned, twice daily milkings were the rule and the total lactose secreted used in part as criterion of the effect of the treatment. The simple method of recording the total amount of lactose secreted during an experiment does not appear to be valid, because of the evidence in support of the idea that the mammary gland is not completely drained of its milk even after careful stripping. In fact, it appears probable from the work of Hammond (7) and Gaines and Sanman (4) that a very considerable amount of milk remains in the gland. For this reason, if the total sugar secreted during the experiment were alone considered, part of that would undoubtedly have been elaborated before its commencement, and again part of the milk elaborated during the experiment must have been retained.

In these studies, therefore, frequent samples of milk were taken in order to be able to match the trend of lactose synthesis during each experiment, and the total amount of lactose produced has been considered as only of secondary importance.

METHODS

The same technique for the collection and storage of the milk and blood samples was employed as already outlined. The milk was analyzed by the Bierman and Doan method (1).

The blood sugar was determined by the Folin-Wu (3) method. The intravenous injections into the jugular vein were made without removing the needle through which a blood sample had just been collected, a one hundred cc. hypodermic syringe being used for this purpose. The insulin used was prepared by Stearns and had a strength of 20 units per cc.

EXPERIMENTS

In order to determine the amount of insulin necessary to produce hypoglucemia in the bovine, an initial experiment was conducted. One hundred

units of insulin were injected, intravenously, into a lactating Jersey cow. This produced a hypoglycemia in which the blood sugar dropped from .064 to .043 per cent during the first half hour following the injection. Two hours later, however, the blood sugar was back to normal. The experiment indicated that if a prolonged hypoglycemia were desired, it would be necessary to increase the insulin dosage and to follow the initial dosage with injections at intervals to prevent too rapid recovery to the normal level.

In the three experiments reported on the following pages, insulin was injected into two lactating cows. Cow 143 was a pure bred Jersey, giving an average daily yield of 10.5 lbs. of milk, while cow 538, a pure bred Guernsey, was giving about 19 lbs. daily.

In Experiment 1 (cow 143) 800 units of insulin were injected in four equal portions at 8:40 A.M., 11:10 A.M., 11:50 A.M. and 1:55 P.M.

In Experiment 2, cow 143 was used again but was not given any food for 48 hours before the experiment, and, while on trial, 1,000 units of insulin were administered in five portions of 200 units each at 9:45 A.M., 11:50 A.M., 4:00 P.M., 9:00 P.M. and at 4:00 A.M. the following morning.

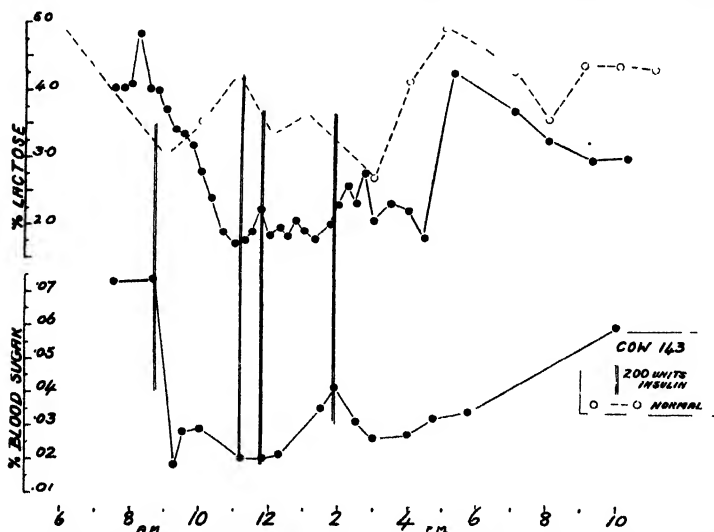


FIG. 1. PRODUCTION OF HYPOGLUCEMIA AND THE DECREASE IN THE LACTOSE CONTENT OF MILK BY INTRAVENOUS INSULIN INJECTIONS.

Jersey Cow 143.

Protocol.

8:40 A.M. 200 units insulin injected into jugular vein.

11:10 " 200 " " " " " "

11:50 " 200 " " " " " "

1:55 " 200 " " " " " "

Temperature of animal remained normal (101.3–101.7) throughout the experiment, and animal showed no effect of the injections except for slight muscular tremors in region of thighs and udder, of few minutes' duration about 9:30 A.M.

In Experiment 3, cow 538 was taken off its ration 12 hours before the experiment, 600 units of insulin were injected at 8:08 A.M. and 400 more at 12:20 P.M.

RESULTS

The results of the above three experiments are graphically recorded in Figures 1, 2, and 3.

DISCUSSION OF RESULTS

Regardless of the fact that in one case the animal had been fasting for two days previous to the commencement of the experiment, in all three experiments the insulin injections resulted in a marked hypoglycemia. The artificial hypoglycemia was followed by a decrease in the lactose content of the milk in each instance, but in Experiment 3 the amount of milk obtained was so far below the average hourly output that the mixing process possibly

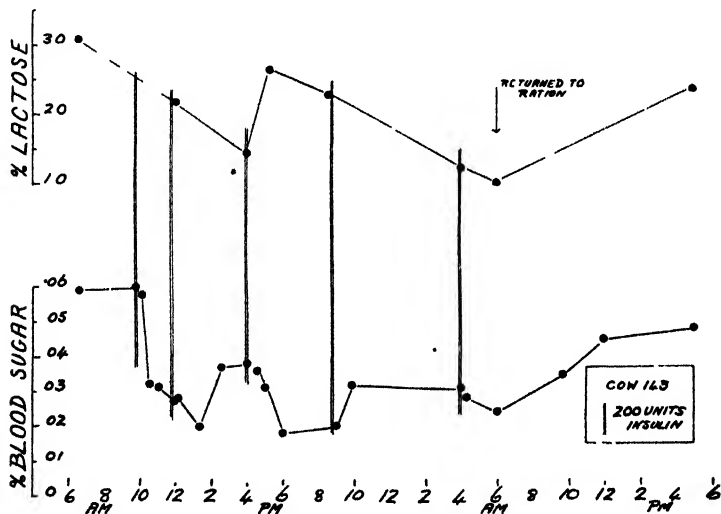


FIG. 2. PRODUCTION OF HYPOGLUCEMIA AND THE DECREASE IN THE LACTOSE CONTENT OF MILK BY INTRAVENOUS INSULIN INJECTIONS.

Jersey Cow 143.

Protocol.

9:45 A.M. August 14, 200 units insulin injected into jugular vein.

11:50 " " " 200 " " " " " "

4:00 P.M. " " " 200 " " " " " "

9:00 " " " 200 " " " " " "

4:00 A.M. August 15, 200 " " " " " "

The animal was taken off food for 48 hours before the first insulin injection.

Mild muscular tremors were noted one minute after the first injection. Fifteen minutes later there was a marked dilation of the pupils, and the animal appeared depressed. Five minutes later, complete recovery was noted with no further appearance of abnormal symptoms following the subsequent injections. No temperature change was noted. The animal stopped secreting milk about seven days after the termination of the experiment.

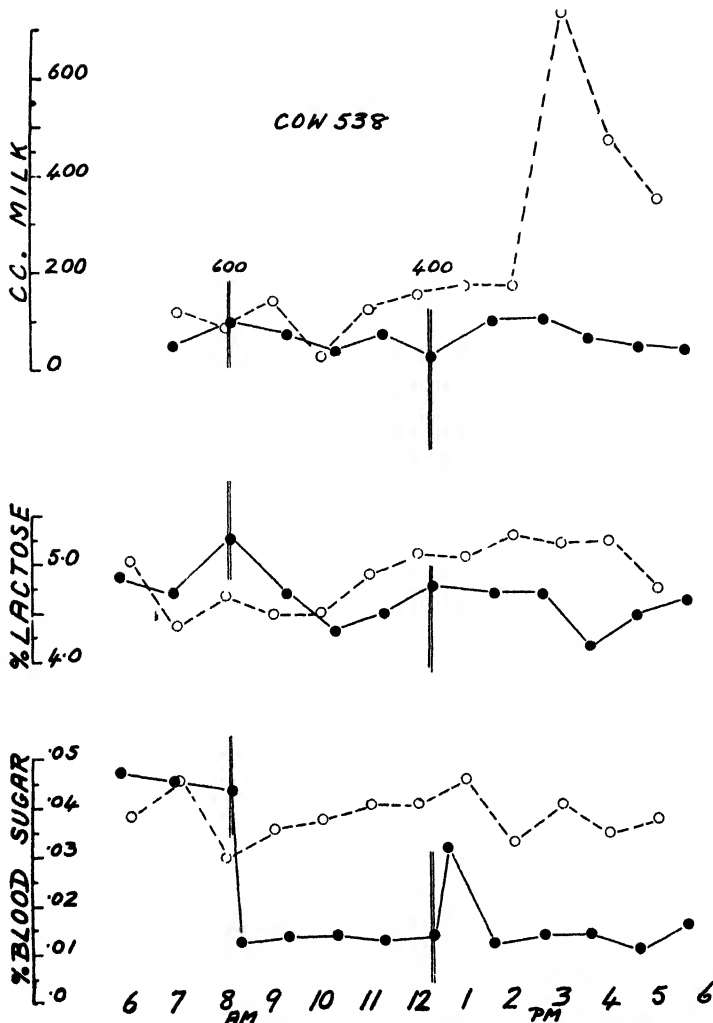


FIG. 8. PRODUCTION OF HYPOGLUCEMIA AND THE DECREASE IN THE LACTOSE CONTENT OF MILK BY INTRAVENOUS INSULIN INJECTIONS.

o ——— o ——— o Effect of insulin
 o - - - - o - - - - o Normal

Guernsey Cow 538.

Protocol.

8:08 A.M. 600 units insulin injected into jugular vein.

12:20 P.M. 400 " " " " " "

The animal was taken off food for 12 hours before the first insulin injection.

The temperature of the animal remained normal throughout the experiment. No abnormal symptoms were noted.

masked to some extent the actual low lactose secreted. While most value is placed upon the lactose percentage for reasons already explained, in two experiments the total milk secreted was measured and the lactose output calculated. Cow 143 in Experiment 2 secreted during the twenty-nine hours 19.6 gms. of lactose, in comparison to its calculated normal secretion of 298.7 gms. for the same length of time. In Experiment 3, cow 538 secreted 32.7 gms. of lactose as compared with the 129.4 gms. actually obtained in the same duration two days previously.

It is thus seen that insulin besides reducing the lactose content of the milk also apparently reduces to a marked degree the total lactose secreted by reducing the milk yield much below even the amount which might be attributed to the extra handling involved in such frequent milkings. Cow 143 secreted very little milk after the termination of the experiment, and lactation had completely stopped one week later.

In general, the milk sugar curves appear to follow the blood sugar curves by approximately one hour. While the blood and milk samples in the two experiments with cow 143 were not taken at the intervals we have found most desirable for the application of statistical methods, in the experiment with cow 538 care was taken to do this. When the blood sugars were correlated with the milk sugars of samples collected almost simultaneously a correlation of $+ .2485 (\pm .271)$ was obtained, but when the blood sugars were correlated with the milk sugars obtained one hour later the correlation was $+ .6084 (\pm .190)$. Thus again the evidence indicates the latter method of sampling for blood and milk sample comparisons is to be preferred to the simultaneous collection of blood and milk samples.

Apart from the above considerations, the apparent vagaries of the blood sugar and milk sugar curves are themselves interesting. It will be noticed that in general an insulin injection resulted in an immediate drop in blood sugar, but when the hypoglucemia was greatest an insulin injection was actually followed by a rise in blood sugar. This effect was observed in all three experiments, but at present its cause is obscure. While most workers have found that the blood sugar drops sharply when insulin is injected and then rises slowly to its normal level, these curves show several points where sharp rises occur for a short period only to quickly level off.

In the light of our more recent work, it is thought that these rises are caused by an infiltration of the already elaborated lactose from the mammary gland to the blood in an attempt of the system to stabilize itself. In all of these experiments the milk sugar curves follow the blood sugar reasonably well until the regular afternoon milking time. Towards this time, the milk obtained commenced to increase in volume until the milking hour when the milk sample increased to many times that of the samples collected during the other milkings. The increase in milk volume was also accompanied by an increase in the lactose percentage of the milk, and the latter is not re-

flected in a similar blood sugar rise. In explanation of this, the suggestion is offered that the animal towards its regular milking time releases, probably by a conditioned reflex, the milk elaborated in the gland before the onset of hypoglycemia. Further evidence of this is the failure of the milk of cow 143, Figure II, to show an increased sugar content at the following milking (6:00 A.M.), a condition undoubtedly due to the then stored milk being secreted against a lower blood sugar level.

Since these insulin injections were completed, Gowen and Tobey (5) have reported results of insulin injections into lactating cows.

In general, their results are quite similar to ours, but, while we obtained a more rapid and lower sugar level in our cows than they did in theirs, we could not produce the comatose condition which they report. Our insulin injections, furthermore, resulted in a lower lactose content than Gowen and Tobey obtained.

SUMMARY

1. Hypoglycemia produced by insulin results in a marked decrease in the lactose content of the secreted milk of cows.

2. No paresis or coma was noted in any of the animals, although the blood sugar was reduced in one case to .01 per cent.

3. In two of the three experiments, a marked similarity was obtained in the trend of the blood sugar and milk sugar curves.

4. An increase in blood sugar following an insulin injection was found to occur when the blood was markedly depleted of sugar.

5. A rise in lactose at about the normal evening milking period was not forecast by an increase in the blood sugar.

6. It was suggested that the rise in lactose just noted was due to an out-flow of stored milk secreted before the onset of the experimental hypoglycemia.

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American Dairy Science Association Announcements

ANNUAL MEETING

PENNSYLVANIA STATE COLLEGE

STATE COLLEGE, PA., JUNE 16-19, 1936

GENERAL INFORMATION

The Meeting will open officially at 1:00 P. M. on Tuesday, June 16, with the Extension Section in session from 1:00 to 4:00. Judging Conferences will be held on Tuesday, the forenoon being given over to dairy cattle and the afternoon to dairy products.

Registration will begin on Monday, June 15. Rooms will be available in the College Dormitories at 75¢ per night double, or \$1.00 per night single. Entertainment for ladies and children will be provided.

Further details will be published in succeeding issues of the JOURNAL OF DAIRY SCIENCE.

CALL FOR PAPERS AND ABSTRACTS

This is the first but not final official call for papers for the Scientific Sessions of the Association. Individual notices will be sent to members or to department heads. It is anticipated that Scientific Programs will be conducted in the subject matter fields of Production, Manufacturing, Extension, and Instruction.

Members are invited to send titles of papers to the Program Committee. Non-members are permitted to read papers if a member of the American Dairy Science Association is a co-author. All papers must represent original work not previously published. Titles of papers should be accompanied by or followed by abstracts, both of which must be in the hands of the Chairman of the Program Committee on May 1st. Papers which are not selected by the committee for the General Session will be placed in the proper section program, but will be subject, however, to the time limit of that section.

Authors are invited to indicate the Section before which they desire to present their paper. One General Scientific Session will be held at which authors will be entitled to 20 to 25 minutes to present their papers. The time allotment in other sessions will likely be no more than 15 minutes. Papers intended for presentation before the General Session must be presented to the Committee in full as well as in abstract form before May 1st.

The members of the Program Committee are J. M. Sherman, L. S. Palmer and S. I. Bechdel, Chairman. The latter may be addressed at the Depart-

ment of Dairy Husbandry, The Pennsylvania State College, State College, Pennsylvania.

WESTERN SECTION MEETING

The Western Section of the American Dairy Science Association held its twenty-first annual meeting in the Multnomah Hotel, Portland, Oregon, on October 6, 1935. Chairman J. A. Nelson presided. The Judging Contests for dairy cattle and for dairy products were again held in connection with the Pacific International Livestock Exposition. As in former years the papers presented at the meeting have been mimeographed in full together with the report of the business session.

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NORMAL VARIATIONS IN THE CURD TENSION OF MILK¹

W. H. RIDDELL, W. J. CAULFIELD AND C. H. WHITNAH
Kansas Agricultural Experiment Station, Manhattan

In the course of an investigation (3) started in the summer of 1932 to study some of the factors influencing the Hill curd test, opportunity was given to observe some of the normal variations in the curd character of milk. The milk of each cow in the Kansas Agricultural Experiment Station dairy herd was tested for curd tension at monthly intervals over an extended period. It soon was evident that more variation in curd tension prevailed than the available literature would indicate. This raised the question as to how frequently tests should be run on a group of cows to insure the production of milk of strictly soft curd character. Since conclusive data were lacking on the influence of a number of other factors, the present investigation was outlined to study (1) daily variation in the curd tension of milk from individual cows, (2) influence of stage of lactation, (3) influence of breed, (4) variations in milk composition and curd tension following freshening, and (5) correlation between curd tension and the protein content of milk.

Alleman and Schmid (1), in an early study, found the individuality of the cow to be an important factor influencing curd character. Most of our information on the variations in the curd character of milk, however, have come from the pioneer observations of Hill (9). More recently Berry (2) and Doan and Welch (5) have reported on the influence of such factors as the individual milking, colostral period, season and stage of lactation.

EXPERIMENTAL

The technique followed was that recommended by Hill (8), with the one modification suggested by Monier and Sommer (10) of adding the 10 c.c. of coagulant to the coagulation cylinder before the milk is introduced. This method was found to be fully as accurate and more rapid than the original Hill procedure. A water bath, accommodating 36 coagulation cylinders, facilitated the running of a large number of samples under carefully controlled conditions. Caulfield and Riddell (3) have shown temperature and

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¹ Contribution No. 101, Department of Dairy Husbandry, and No. 193, Department of Chemistry.

time of cutting to be important factors influencing the accuracy of the test. All tests were run in triplicate at 35° C. and the more recently developed curd-o-meter,² which cuts down through the curd, was used in cutting all samples.

DAILY VARIATIONS IN CURD TENSION

Data are presented in Table I on the daily variation in curd tension over a 10-day period for representative cows of soft, medium and hard curd tendencies. These results are typical of the fluctuations in curd tension over a limited period of time. While Hill has designated milk of 20 grams curd tension or less as soft curd, the number of cows testing this low in any herd is so extremely limited that 30 grams or less has been accepted as the standard for soft curd milk in a majority of cases. Furthermore, there is a current impression that a single test is sufficient to identify the curd character of a cow's milk and that this value holds throughout the lactation and the cow's lifetime. The first three cows listed in Table 1 were producing milk of approximately soft curd character. An average coefficient of variation of approximately 20 per cent is indicated for these cows. The daily variation in curd tension is of sufficient magnitude to warrant rather careful selection of the producing unit. It would seem desirable, therefore, to make several consecutive tests on a group of cows before final selection, if milk of soft curd character is to be produced.

TABLE 1
Daily variation in curd tension values within periods of 10 days

COW NO.	AVERAGE VALUE	COEFFICIENT OF VARIATION	RANGE
	(grams)		(grams)
1	19.1	23.5	12- 27
2	28.0	15.1	22- 34
3	32.4	17.1	20- 42
4	40.0	13.8	32- 48
5	65.0	17.7	44- 84
6	83.5	7.5	74- 94
7	91.4	9.8	78-104

INFLUENCE OF STAGE OF LACTATION ON CURD TENSION

The data on the influence of stage of lactation on curd tension are presented in Table 2. Complete lactations were not available on all cows due to differences in time of freshening. However, all lactations involved were at least five months in length and the figures in each case represent the average of the data available for each month. These results can be taken as rep-

² Heusser Instrument Manufacturing Co., The American Curd-O-Meter. Bulletin 54. 1932.

representative since the average figures obtained for 21 complete lactations of 10 months or longer show the same general trend.

It will be observed that there is a tendency for the curd tension to increase from the second month to the end of the lactation. A general scrutiny of the data shows that the curd tension does not remain uniform throughout the lactation, although there is no pronounced increase in successive months and the curd tension values may be fairly uniform for a period of several months. This condition applies also in the case of typically soft curd producers. It will be noted that from the second through the fourth month, the last group in Table 2 would hold this classification. Throughout the remainder of the lactation, particularly from the eighth month to the end of the period, a more rapid increase took place, with the result that the average curd tension was more than 100 per cent higher in the tenth month than in the second.

These findings are not in agreement with those of Hill (9) and Berry (2), both of whom reported that excluding the beginning and final months the curd tension remains fairly constant throughout the lactation period. Furthermore, these results would emphasize the necessity of making at least two or three tests of the milk throughout the lactation of each cow in the soft curd group if the uniformity of the product is to be guaranteed in this respect.

Occasionally samples of milk which failed to set a curd were obtained from cows well advanced in lactation. This fact also has been commented upon by Hill (9).

TABLE 2
Influence of stage of lactation on curd tension (in grams)

NO. LACTATIONS AVERAGED	MONTH OF LACTATION											
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
86 partial	79	40	46	51	56	56	59	62	62	64	66	75
21 complete	77	45	54	55	65	60	62	67	70	73	70	79
18 (soft curd)	58	24	27	34	41	40	40	47	54	58	53	67

CHANGES IN CURD TENSION VALUES AND MILK COMPOSITION FOLLOWING PARTURITION

Hill (9) reported that milk is considerably higher in curd tension during the first month or six weeks than later. Berry (2) found in colostrum studies on 26 cows that the milk reaches a normal curd tension by the tenth day. Since the number of cows producing soft curd milk is quite limited, it is important to know how soon after freshening the milk of such cows is available for consumption.

The data in Table 3, giving individual results on 8 cows, show the fluctuations in curd tension values following freshening. These figures

indicate that while the milk of some individuals has attained uniform curd tension values at the end of 10 days, in a majority of cases at least two to three weeks were necessary for this to take place. Attention is directed to the irregularity in behavior of curd tension values for the first few days following parturition. In a few instances the highest curd tension is registered with the initial colostrum, followed by an irregular decrease until uniformity is attained. In the majority of cases, maximum values were observed on the third to fifth days following freshening. This irregular behavior in curd tension following parturition probably can be related to the major variations in the serum solids portion of the secretion, particularly in the protein and ash constituents.

In a parallel study of the changes in composition of milk following parturition, some interesting results were secured, which can be used, in part, to explain the changes in curd tension. These data are presented in Table 4 and, so far as the authors are aware, are the most extensive observations on the changes in the major constituents of milk for breeds in this country for approximately the first month after freshening. While some attention has been paid to this phase of lactation by other workers, the data are limited. Crowther and Raistrick (4) reported analyses of the proteins of milk for the first eight milkings after freshening. Engel and Schlag (6) made rather comprehensive determinations on the milk of one cow, showing the changes of colostrum into milk over a period of 7 days. The figures in Table IV represent averages of determinations on 7 cows over the first 28 days of their lactation.

The first milk is an especially rich secretion averaging approximately twice as rich in total solids content as the later normal milk. This, undoubtedly, depends to a considerable extent on the length of the dry period and the level and nature of the feeding during this period. The striking feature about the colostrum is the extremely high globulin content. Crowther and Raistrick (4) have reported the presence of about 0.03 per cent globulin in normal milk. It will be noted that as late as the 28th day after freshening the value for globulin is still appreciably higher than normal. Average values for albumin, casein and ash are all considerably higher in the first milk, while the sugar is approximately 50 per cent of normal. The fat, on the other hand, shows no consistent change. In general the most rapid decline in all constituents, with the exception of the sugar, has taken place within the first four milkings following parturition. The milk sugar has made the most rapid increase within this same period. It will be observed from the data in Table III that the curd tension reaches a maximum average value at approximately the same time. Espe and Dye (7) and Weisberg, Johnson and McCollum (11) have demonstrated a close correlation between the amount of casein in milk and the resulting curd tension. The influence of the mineral portion and the concentration and manner of dispersion of

TABLE 3
Changes in curd tension values following parturition (in grams)

SAMPLE TAKEN	I. (HOL.)	II. (HOL.)	III. (HOL.)	IV. (HOL.)	V. (AYR- SHIRE)	VI. (AYR- SHIRE)	VII. (JERSEY)	VIII. (JERSEY)	AV. CURD TENSION
1st milking	117	20	63	115	82	40	154	30	77
2nd "	94	46	28	144	84	36	133	34	75
3rd "	95	112	21	100	96	51	133	32	83
4th "	67	118	48	83	95	84	178	44	90
3rd day	81	100	45	103	96	114	139	98	97
4th "	73	104	38	92	96	123	112	76	89
5th "	58	89	28	71	126	94	88	84	80
7th "	56	69	28	78	52	54	73	70	60
10th "	38	48	26	55	36	54	91	72	53
14th "	36	40	10	55	39	39	78	53	44
21st "	30	32	19	32	36	42	73	51	39
28th "	30	36	21	40	29	40	83	52	41

the fat on the curd character also has been pointed out. In the present study a correlation of $0.76 \pm .04$ was obtained between the curd tension and the total protein content of 58 samples of normal milk from the Kansas Agricultural Experiment Station herd of the four major breeds. This would indicate that the protein is a major factor producing differences in curd tension, but that other factors also have a modifying influence.

In view of the high correlation between the casein and curd tension in normal milk, the question may be raised as to why the curd tension values do not correlate more closely with the casein in the initial 3 or 4 milkings. (See Tables III and IV). From the fourth milking through the remainder of the first month's lactation the correlation between the casein or total protein and curd tension is more regular. In the early milkings, the high globulin and albumin content of the milk undoubtedly are modifying influences. As their concentration decreases at a very much more rapid rate than does the casein, the latter soon becomes the dominant factor influencing curd tension.

TABLE 4
Changes in composition of milk following parturition¹
(Values in per cent)

SAMPLE TAKEN	ALBUMIN	GLOBULIN	CASEIN	ASH	SUGAR	FAT	T S ²
1st milking	2.62	7.90	6.99	1.26	2.62	5.4	26.79
2nd "	1.66	5.44	6.12	1.10	3.23	4.9	22.45
3rd "	.48	2.19	4.16	.91	4.18	5.0	16.92
4th "	.55	1.27	3.97	.90	4.32	4.1	15.11
3rd day	.28	.72	3.98	.89	4.49	4.5	14.86
4th "	.39	.49	3.62	.84	4.61	4.2	14.15
5th "	.17	.47	3.17	.81	4.72	4.5	13.84
7th "	.22	.40	2.90	.79	4.67	4.4	13.38
10th "	.21	.34	2.78	.77	4.83	4.8	13.73
14th "	.19	.31	2.68	.75	4.74	4.6	13.27
21st "	.20	.34	2.54	.74	4.78	4.5	13.10
28th "	.29	.27	2.55	.74	4.57	4.6	13.02

¹ Average figures for group of cows made up of 3 Holsteins; 2 Guernseys; 1 Ayrshire; 1 Jersey.

² Calculated sum of the constituents.

INFLUENCE OF BREED ON CURD TENSION

There is a good deal of interest in the influence of the breed on curd tension. Hill (9) reported the first results from herds tested in Utah, with only a limited number of cows of the Guernsey and Ayrshire breeds represented. The Ayrshire breed association³ since has published figures showing a higher percentage of soft curd cows for that breed. In view of the marked correlation between protein and curd tension, it would be expected that in

³ The Ayrshire Digest, 18: 3-6, 1932.

curd tension distribution the different breeds would rank approximately in the same order as the average casein or total protein content of their respective milks. Under these conditions one would expect the percentage of soft curd cows to decrease in the different breeds in approximately the following order: Holstein, Ayrshire, Guernsey and Jersey.

The results of a considerable number of determinations run on the milk of these breeds during the past two years show this to be the case. These figures are given in Table 5 and represent values obtained for the cows in the herd of the Kansas Agricultural Experiment Station and samples submitted by dairymen in the state. The number of cows tested in the Jersey breed is not large, but since the results for this breed agree fairly well with the distribution observed by Hill (9) it is felt that they are sufficiently representative for the purposes of this comparison. If a curd tension of 30 grams or below is considered as the dividing line for soft curd milk, it will be seen that the Holstein breed has an appreciably higher percentage of cows in this classification than the other dairy breeds, followed by the Ayrshire, Guernsey and Jersey breeds in the order listed. In general, Holstein milk shows a lower average curd tension and the percentage of cows testing over 80 grams is substantially lower than for any of the other breeds. Considering the similarity in composition, it is rather surprising that the Guernsey breed shows a significantly higher percentage distribution in the lower classifications than the Jersey breed.

TABLE 5
Percentage distribution of curd tension by breeds

BREED	NO OF COWS TESTED	NO OF TESTS RUN	CURD TENSION—GRAMS					
			Below 30	31-40	41-60	61-80	81-100	Over 100
Ayrshire	55	419	10.9	20.1	37.6	19.2	10.3	1.9
Guernsey	70	221	8.1	15.4	36.2	23.1	12.3	4.9
Holstein	157	442	18.5	22.9	35.1	18.5	4.5	0.5
Jersey	21	172	2.9	4.1	16.9	27.9	24.4	23.8

SUMMARY AND CONCLUSIONS

Using a modification of the Hill technique for determining curd tension, a study was made of a number of the principal factors influencing the curd tension of milk under normal conditions.

The daily variation in cows producing milk ranging from soft to medium curd tension was observed to be significant in the selection of cows for the production of soft curd milk.

Stage of lactation was found to have a considerable influence on the curd tension. Following a rapid decline in the first month, the lowest values were obtained in the second and third months, followed by a gradual and significant increase to the end of the lactation. This held true for producers of soft curd milk, average values being obtained in the tenth month that were approximately 100 per cent higher than in the second month of the lactation. The influence of daily variation and stage of lactation emphasize the need for regular tests if milk of strictly soft curd character is to be produced.

Data are presented on the important changes in the composition of milk for approximately the first month following parturition. The relation of these changes to the curd tension behavior are discussed. A correlation of $0.76 \pm .04$ was obtained between curd tension and the total protein content of milks on 58 samples of milk from the experiment station herd.

The breed was found to be one of the most important factors influencing curd tension. In the present study the breeds ranked in the following order of decreasing importance as producers of soft curd milk—Holstein, Ayrshire, Guernsey and Jersey.

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RENNET TEST FOR THE DETECTION OF MASTITIS*

F. B. HADLEY

Department of Veterinary Science, University of Wisconsin, Madison

The observation that milk from cows with mastitis does not coagulate readily, or not at all, with rennet is not new. Apparently Schern (1, 2, 3, 4, 5) was the first investigator to describe and employ a standardized technic for retarded rennet coagulation for the diagnosis of mastitis. Laue (6) experimented with Schern's test and reported it to be unreliable. Orla-Jensen (7) suggested that rennet would be helpful in determining if milk has been drawn from a diseased udder, but he apparently never applied the suggestion in a practical way. Rosell (8) stated that the capacity of mastitis milk for coagulation by rennet is greatly diminished because of the decrease and changes in casein, but he has not published detailed directions for the use of rennet for such purpose. The test to be described in this paper was first demonstrated before the Dairy Manufacturers' Short Course (9) at the University of Wisconsin.

PRELIMINARY STATEMENT

The test with rennet is based upon the principle that the enzyme rennin readily causes the casein fraction of normal milk to coagulate. Abnormal or mastitis milk has less casein and calcium than normal milk, so does not coagulate so quickly, if at all. Another factor responsible for failure of mastitis milk to coagulate is the increased pH.

For most reliable results with the rennet method of testing for mastitis individual quarter samples of fresh milk should be taken. Mastitis milk, even when diluted so low as 1:3 with normal milk, may not react with this test on account of the dilution factor. Likewise a composite milk sample from the four quarters of the cow, or mixed samples from cans or bottles are not suitable. As the first drawn milk is more likely to give a reaction when this method is used, it is preferable to middle milk or strippings.

An especially desirable feature of the rennet test is that no expensive laboratory equipment is required. However, if an incubator is available to hold the temperature at a given point, more uniform results can be secured. A supply of test tubes of 10 or 15 cc. capacity and one 1-cc. pipette graduated in 1/10ths is all the glassware needed. In place of the pipette a dropper with rubber nipple adjusted to deliver the required amount of rennet solution may be used. Suitable racks for holding the test tubes are desirable. Either an interval timer, or a stop watch, will be found helpful.

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TECHNIC OF THE RENNET TEST

The rennet testing solution consists of one part fresh, commercially prepared fluid rennet extract mixed with 50 parts distilled water. A fresh solution should be made whenever tests are to be run as the diluted extract rapidly loses its coagulating power. Five cubic centimeters of milk from the quarter to be tested are drawn directly into a test tube, which has a mark indicating the height to which the tube should be filled. To this milk sample is added 0.1 cc. of the diluted rennet, making a final dilution of 1:2500. This combination is mixed by inverting the tube and allowed to stand one hour at room temperature ranging from 72° to 82° F. Normal milk will coagulate within this period. Samples that fail to coagulate are abnormal. Coagulation is determined by tilting the tubes to a horizontal position. The test is used as presumptive evidence of mastitis. Degrees of the disease can be detected by noting the results at 15-minute intervals.

Workers should appreciate that mastitis milk not only has less casein, but also a lowered concentration of sugar, and calcium and potassium salts, all of which are substances elaborated by the milk-secreting cells of the udder. On the other hand, mastitis milk has a higher water content and contains more albumin, chlorides, catalase and leucocytes, all of which are substances derived directly from the blood and are increased as a result of the inflammatory process. Furthermore, such milk usually is more alkaline in reaction than normal milk and its nutritional value is lower. Practically it is interesting to note that the value of mastitis milk for cheese manufacture is strikingly reduced. The chief difference according to Prof. W. V. Price, of Wisconsin, is in the nature of the curd, which is decidedly soft and correspondingly more difficult to handle. Another drawback is the loss of more butterfat during the manufacturing process, resulting in less economical cheese production.

EXPERIMENTAL

A comparison of the results of testing with rennet 20 samples of milk from five different cows is presented in Table I. These particular cows were selected from the thousands upon which records have been secured because they represent different degrees of mastitis as revealed by the rennet test. By way of explanation it should be stated that the numbers under each cow refer to the quarters: 1 is right front, 2 right rear, 3 left rear, and 4 left front. The + sign indicates no coagulation or a reaction; - coagulation or no reaction; † partial coagulation or an incomplete reaction. The reactions were recorded at 15-minute intervals for one hour in order to determine the rapidity of the reaction, which reflects the degree of infection. For instance, by means of the rennet test it was shown that Cow 1 is mastitis-free; Cow 2 has the disease in quarter 3; Cow 3 in quarters 2 and 4; Cow 4 in quarters 1 and 2, and possibly in 3; Cow 5 in all quarters.

TABLE I
Comparison of results of the Rennet test with other methods

TEMP 78° F	COW 1				COW 2				COW 3				COW 4				COW 5			
Method of testing for mastitis	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Rennet after 15 min.	+	+	?	-	+	+	+	-	+	+	?	+	+	+	+	+	+	+	+	+
" " 30 "	-	?	-	-	-	-	+	-	-	+	-	+	+	+	+	+	+	+	+	+
" " 45 "	-	-	-	-	-	-	+	-	-	+	-	+	+	?	-	+	+	+	+	+
" " 60 "	-	-	-	-	-	-	+	-	-	+	-	?	+	+	-	+	+	+	+	+
Brom cresol purple	-	+	-	-	-	-	+	-	-	+	-	?	+	+	-	-	+	+	+	+
Chlorides	-	+	-	-	-	-	+	-	?	+	+	+	+	?	-	-	+	+	+	+
Catalase	-	-	-	-	?	-	+	-	-	+	-	+	+	-	-	-	+	+	+	+
Bacteriological	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	+	+	+	+	+
Summarized results	-	?	-	-	-	-	+	-	-	+	-	-	+	+	?	-	+	+	+	+

There are also presented for comparison in Table I results secured from testing for mastitis the same series of milk samples by several other diagnostic methods. Although the results do not check exactly, a general relation exists between them. One reason for the variations is that the methods are based on different factors, so are not entirely comparable. This will serve to impress the important point that reliance should not be placed on the results of one test by any method. A more dependable diagnosis can be secured by basing conclusions on the combined or summarized results from several methods of testing, as has been done in the last line of the table. Retests at a later date are desirable in cases of questionable reactions to establish the diagnosis beyond reasonable doubt, as well as to detect new cases. In practice, wider variations will be found than are shown in the results compiled in Table I which it will be recalled were from a selected group of cows. Also values will vary from week to week with the same cow due to changes occurring in composition of the milk.

TABLE II
Comparison of the value of results by combined and single methods

METHOD OF TESTING FOR MASTITIS	SAMPLES ABNORMAL		SAMPLES NORMAL	
	No	Per cent	No	Per cent
Combination of all methods	67	21	247	79
Rennet	62	20	252	80
Brom cresol purple	79	25	235	75
Chlorides	98	31	216	69
Catalase*	64	20	250	80
Bacteriological*	42	19	182	81

* The tests for catalase and bacteriological examinations were made by cooperators in the laboratories of the Department of Agricultural Bacteriology. To avoid complications borderline or suspicious reactions are classified as either positive or negative depending on the degree of reaction.

In Table II a comparison is made of the value of a combination of the various methods of testing employed in our experimental work with that of each method. It shows that of the 314 quarter samples of milk tested 67 or 21 per cent were found to be abnormal and 247 or 79 per cent normal. By the rennet method the percentages were 20 and 80 respectively. A higher percentage of reactions was secured with brom cresol purple and the silver nitrate-potassium chromate method for chlorides as described by Hayden (10). This may be accounted for, in part at least, by the concentration of the insoluble and soluble milk salts in some of the samples, which were from cows nearing the end of their lactation period. The results with the catalase method compare favorably to those with rennet, but as they depend upon the number of leucocytes, or their products of disintegration, they also are somewhat influenced by the stage of lactation. The results of the bacteriological examination are not strictly comparable with any of the other methods because they are based on the counts for streptococci rather than on the composition of the milk.

CONCLUSIONS

From this preliminary study it is concluded that (1) the rennet method of testing milk for mastitis is as reliable as any other with which it was compared; (2) all methods have limitations; (3) a more dependable diagnosis can be made if milk samples are tested by two or more methods, *i.e.*, a combination of results by different methods furnishes more reliable information; (4) one series of tests on a herd does not furnish all needed information; (5) the composition of milk from the same quarters of the same cow varies from week to week.

SUMMARY

A new test with fresh commercial fluid rennet for the detection of mastitis is described. It is believed that this method of testing, because of its simplicity and cheapness, may have practical use. Comparisons of the results secured by the rennet method with those secured by other methods are presented.

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BUTTERFAT AND TOTAL SOLIDS IN NEW ENGLAND FARMERS' MILK AS DELIVERED TO PROCESSING PLANTS

MOSES S. JACOBSON

Laboratories of the Whiting Milk Companies, Boston, Mass.

INTRODUCTION

Milk is the whole, fresh, lacteal secretion, colostrum free, obtained by the complete milking of one or more healthy cows, properly fed and kept, and which after production is not altered in composition, adulterated, or processed.

The State of Massachusetts requires that milk shall contain not less than 3.35 per cent of butter fat and 12.00 per cent of total solids, a standard which is inconsistent in its relation of fat to solids-not-fat. In order to meet the requirements it became the practice of milk distributors to standardize solids not fat up to the legal requirements by the addition of condensed skim milk, the amount used varying with the season of the year. Legally one may raise the total solids of milk only by the addition of very rich milk or cream.

If one reviews the standards of our other states, we find whereas certain states set a minimum fat standard, others either fail to recognize the value of a standard for solids-not-fat and total solids, or have such standards that are inconsistent in their relation of fat to solids-not-fat.

In the scoring of solids-not-fat in milk we find that the United States Department of Agriculture has adopted the following standards:

	<i>Points</i>		<i>Points</i>
8.7 per cent and over	15	8.2 per cent	5
8.6 " " " "	13	8.1 " " "	3
8.5 " " " "	11	8.0 " " "	1
8.4 " " " "	9	Less than 8 per cent	0
8.3 " " " "	7		

Note:—When the percentage of solids-not-fat is less than the local limit the score should be 0.

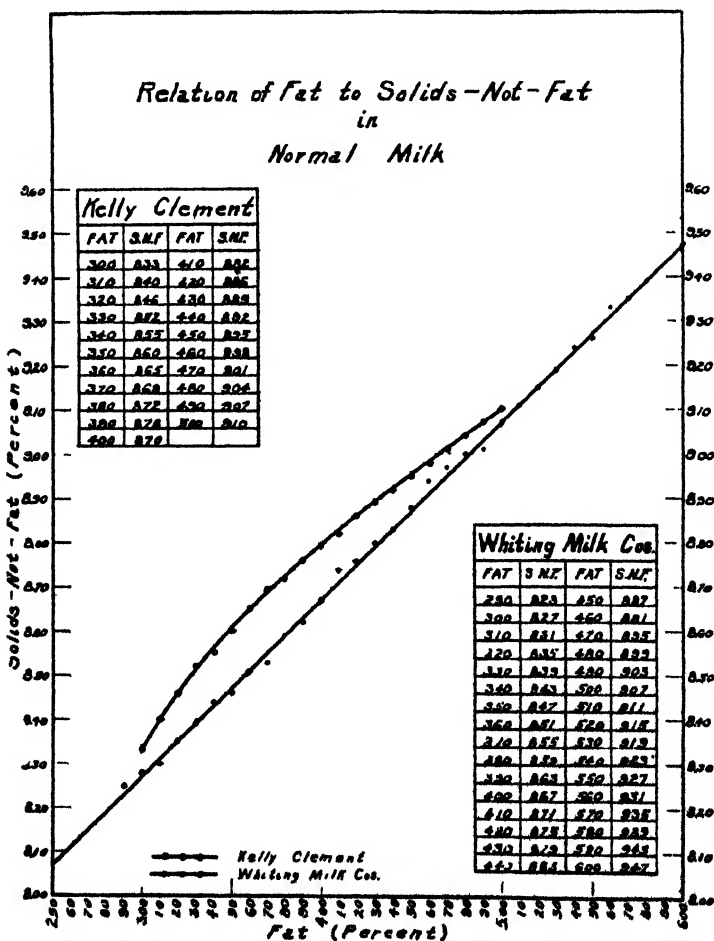
The dairy industry has long recognized the importance of the Babcock test and has regularly provided for the determination of butter fat value in making payment to producers. It has however failed to recognize the importance of solids-not-fat in milk and to provide for the determination of abnormal, watered, skimmed, added cream, or milk of poor quality, all of which results in an unbalanced milk costly to the distributor, who may be subjected to prosecution by health officers.

The president of our company, Mr. Joseph Willmann, knowing the value of solids-not-fat in milk requested that practical provisions be made for the determination of its content in each of our producer's milk at least once weekly.

This work has resulted in a marked improvement of quality and if nationally adopted it would be only a question of time when our general standard of quality would be materially improved and consumption increased.

METHODS

During the past sixteen months over 100,000 samples of Massachusetts, New Hampshire, Vermont, Maine, Connecticut and Rhode Island producers'



milk have been analyzed for fat and total solids. These samples were composed of individual cows, of herds, and of mixed milks, representing all breeds and grades of cows.

The method analysis used was as follows:

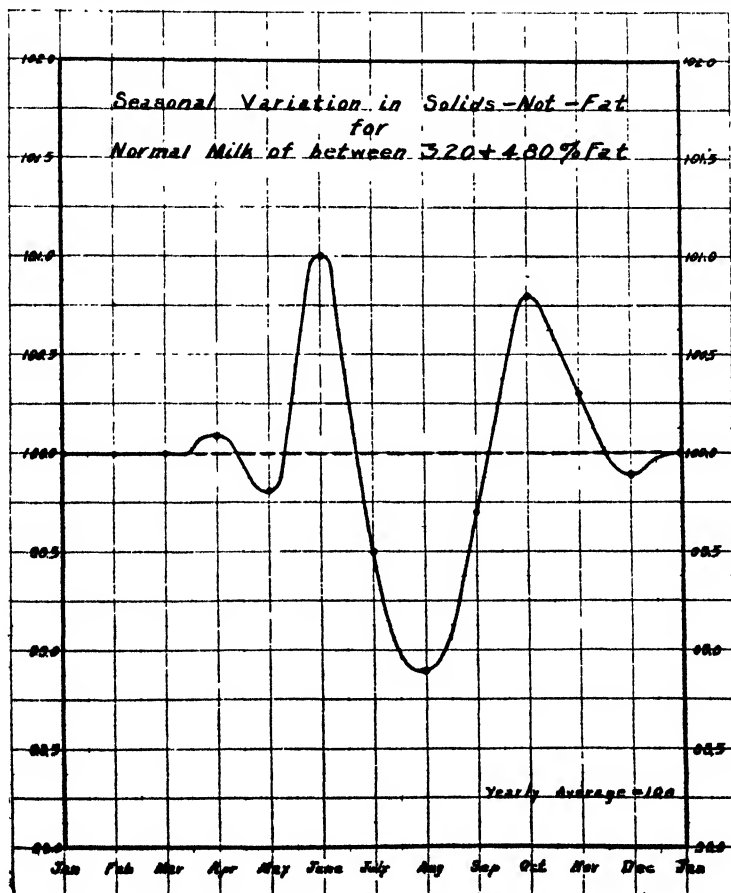
Total Solids—Quickly weigh out 5 grams of a well mixed sample into a tared, flat-bottom dish, and evaporate over a bath of boiling water until it ceases to lose weight (2 hours). Cool at room temperature in a dessicator for five minutes and quickly weigh the residue.

Fat—By the Babcock and Mojonnier methods.

Solids-not-Fat—Obtained by difference.

RESULTS

Chart 1 has been prepared from Table 1 to summarize the findings of



our analyses and represents in excess of 100,000 samples of New England farmers' milk. The work of Kelly and Clement¹ is also given.

In comparing our chart with that of Kelly and Clement, we find our New England milk averaging 0.11 per cent lower in solids-not-fat. Solids-not-fat consistently increase by 0.04 per cent with each increase of 0.1 per cent in fat.

TABLE 1
Relation of fat to other solids in producers milk New England States

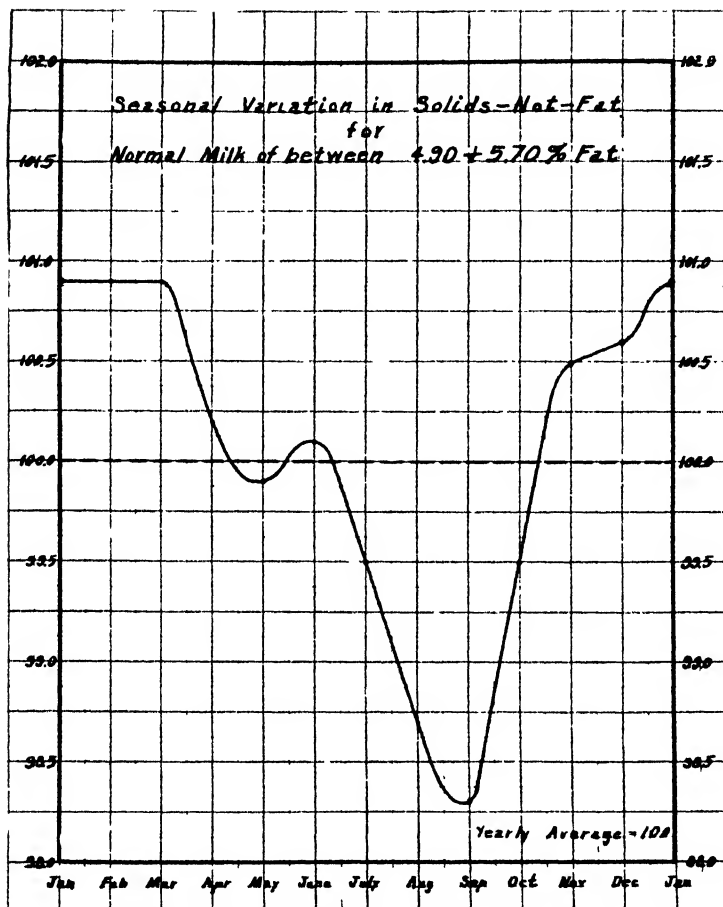
FAT	SOLIDS NOT FAT	TOTAL SOLIDS	RATIO OF FAT TO SOLIDS NOT FAT	SOLIDS NOT FAT IN SERUM
2.80	8.19	10.99	1: 2.93	8.42
2.90	8.23	11.13	1: 2.84	8.47
3.00	8.27	11.27	1: 2.76	8.52
3.10	8.31	11.41	1: 2.68	8.57
3.20	8.35	11.55	1: 2.60	8.62
3.30	8.39	11.69	1: 2.54	8.67
3.40	8.43	11.83	1: 2.48	8.73
3.50	8.47	11.97	1: 2.42	8.78
3.60	8.51	12.11	1: 2.36	8.83
3.70	8.55	12.25	1: 2.31	8.88
3.80	8.59	12.39	1: 2.26	8.93
3.90	8.63	12.53	1: 2.21	8.98
4.00	8.67	12.67	1: 2.17	9.04
4.10	8.71	12.81	1: 2.12	9.09
4.20	8.75	12.95	1: 2.08	9.14
4.30	8.79	13.09	1: 2.04	9.19
4.40	8.83	13.23	1: 2.00	9.24
4.50	8.87	13.37	1: 1.97	9.29
4.60	8.91	13.51	1: 1.93	9.34
4.70	8.95	13.65	1: 1.90	9.40
4.80	8.99	13.79	1: 1.87	9.45
4.90	9.03	13.93	1: 1.84	9.50
5.00	9.07	14.07	1: 1.82	9.56
5.10	9.11	14.21	1: 1.79	9.60
5.20	9.15	14.35	1: 1.76	9.66
5.30	9.19	14.49	1: 1.73	9.71
5.40	9.23	14.63	1: 1.71	9.75
5.50	9.27	14.77	1: 1.69	9.82
5.60	9.31	14.91	1: 1.66	9.88
5.70	9.35	15.05	1: 1.64	9.91
5.80	9.39	15.19	1: 1.62	9.97
5.90	9.43	15.33	1: 1.60	10.00
6.00	9.47	15.47	1: 1.58	10.01

Massachusetts legal requirements not less than 3.35 fat—12.00 total solids.

SEASONAL VARIATION

The seasonable variation in solids-not-fat for normal milks are shown in Charts 2 and 3, the average analyses being taken as 100:

¹ Market milk, John Wiley and Sons, 1923.



It will be noted that the variations in solids-not-fat for normal milk of between 3.20 and 4.80 per cent fat is not so marked and the period of low and high solids-not-fat do not occur in the same periods as normal milk of between 4.90 and 5.70 per cent fat.

DISCUSSIONS AND CONCLUSIONS

The analyses of more than 100,000 samples of milk delivered to plants in New England show that for each increase of 0.1 per cent in butterfat there is a uniform increase of 0.04 per cent in milk solids-not-fat. There is a small seasonal variation in this relationship.

The percentage of solids-not-fat found in this investigation was 0.11 per cent less than the average analysis reported by Kelly and Clement.

Milk containing just enough butter fat to be legal in Massachusetts was below standard in solids-not-fat. Since one can legally raise the milk solids only by the addition of very rich milk it is obvious that these solids are valuable not only from a nutritional and flavor standpoint but also in the cost of producing milk of legal composition.

It is believed that the time may be ripe to establish two legal standards for milk; one to cover the milk sold by producers to dealers, and the other to cover the milk as sold to the consumer. The milk standard for production would permit the majority of all normal herd milk to come within that standard. The standard for milk sold to consumers should require a composition that would ensure a good flavor to assist in increasing the consumption of milk solids by a greater total consumption and by more milk solids per unit volume. This would be brought about by standardization of milk above the production standard by the addition of cream to a four or a four and a half per cent butter fat content.

THE EFFECT OF INTRAVENOUS INJECTIONS OF SUGAR UPON THE LACTATING BOVINE*

W. R. BROWN,¹ W. E. PETERSEN² AND R. A. GORTNER¹

College of Agriculture, University of Minnesota, St. Paul

Having satisfactorily demonstrated that artificially produced hypoglycemia results in a lowering of the lactose content of cows' milk, it was considered desirable to investigate the possibility of an artificially induced hyperglucemia as a means of increasing the lactose content.

HISTORICAL

Effect of sugar injections on milk secretion

Piantoni (7) was the first worker to study the effect of sugar injections upon milk secretion. Using milch goats as the experimental animals, he found that only the mono- and di-saccharides, when hypodermically injected, had any effect on milk secretion. Both mono- and di-saccharides injected in small doses of 1 gram daily resulted in an increased milk secretion but with no change in the lactose percentage. Large doses of sugar, however, decreased both the milk yield and its lactose content and if repeated daily for several weeks diminished the yield as much as fifty per cent.

Sammartino (8) applied Piantoni's discovery to his study with lactating women. He was able to triple the milk secretion by small daily injections of about 5 cc. of 1.5 per cent sucrose in cases where the women secreted too little for their babies, and was able to diminish milk secretion by injecting 5 cc. of 40 per cent sucrose daily in cases where it was advisable to check secretion.

Monaco, Nazari and Romolotti (5) were likewise able to increase the milk secretion in cows already producing a large quantity of milk by means of subcutaneous injections of sucrose. Campus (2) also reports an increase in the quantity of milk produced by three ewes, following ten daily subcutaneous injections of 1 cc. of a 50 per cent sucrose solution.

Effect of sugar injections on the percentage of lactose in the milk

Nitzescu (6) made intravenous injections of glucose, levulose, galactose, maltose and sucrose into milch goats at the rate of 1 to 2 grams per kilo live weight. He found that only the mono-saccharides and maltose can be used

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¹ From the Division of Agricultural Biochemistry, University of Minnesota.

² From the Division of Dairy Husbandry, University of Minnesota.

for sugar synthesis and observed no change in the quantity of milk secreted or in its fat content, but a slight change in the lactose content. He concluded that the mammary gland retains an autonomy as regards lactose secretion, which is produced in a very constant manner in spite of wide blood sugar variations.

Macchiarulo (4) says he has produced hyperglucemia in a goat by the injection of 200 cc. of 15 per cent glucose. He asserts he obtained an increase of lactose in the milk but fails to substantiate his claim with numerical data

THE PROBLEM

Several workers have made intravenous sugar injections into various species of lactating mammals with the object of determining the effect upon the quantity of milk produced.

Nitzescu (6) alone reports a slight increase in the lactose content following sugar injections into milch goats. It was therefore considered that a further study of this subject, using the lactating bovine, would be of value.

Successive experiments using glucose, glutose, fructose, and lactose were planned in which repeated injections of the particular sugar would be made in an attempt to produce a hyperglucemia for several hours so that a marked effect upon the sugar content of the milk would be possible.

EXPERIMENTAL

Methods

All samples were collected, and the sugar determinations carried out in the manner previously described.

Intravenous injections

The intravenous sugar injections were made into the jugular vein with a 100 cc. hypodermic syringe, immediately after the collection of a blood sample and without the removal of the needle. Sterilized isotonic sugar solutions were used in all the experiments.

Experiments

The first three experiments consisted of the hourly milking out of cows and the periodic intravenous injection of sugar solutions. In these initial experiments only small amounts of sugar were used.

In Experiment 1, cow 544 was milked at hourly intervals from 6:30 A.M. until 11:30 A.M. when an initial dose of 3.5 grams of glutose was injected into the jugular vein. A second dose of similar size was injected at 2:10 P.M. while a third and last dose of 3.5 grams of the same sugar was given at 3:15 P.M.

As the lactose showed no pronounced increase following the glucose injections, it was decided to use the common sugar glucose instead and to increase the frequency of injections.

In Experiment 3, cow 538 was milked hourly from 6:00 A.M. and intravenous glucose injections were made at 8:20 A.M., 10:10 A.M., 11:10 A.M., 12:10 P.M. and 2:10 P.M., a total amount of 64 grams of glucose being injected. The protocol of this experiment accompanies the results obtained which are illustrated in the lower half of Figure 1.

Failing to produce any marked changes in the secretion during the first three experiments, it was decided to extend the scope of the work by the additional collection of blood samples in the hope that the blood sugar curves would facilitate in the interpretation of the results.

Glucose, fructose and lactose were the sugars used in these additional experiments.

In Experiment 4, cow 538 was injected four times over a period of three hours with a total of 217 grams of glucose.

Experiment 5 consisted of two intravenous injections totaling 35 grams of fructose into cow 167 while in Experiment 6, cow 165 was injected four times with a total of 34 grams of fructose.

In Experiment 7, 35 grams of lactose were injected at one time into cow 167.

Because every intravenous injection, with the sole exception of the lactose injected in Experiment 7, failed to produce but a very temporary hyperglucemic condition, a slow injection was attempted in Experiment 8 in hope that constant high level of glucose could be maintained. For this purpose a board was wired to the horns of cow 538 and one ear strapped to it. The fastened ear was anesthetized with novocain and a fine hypodermic needle then inserted into an ear vein. The glucose solution was forced by air pressure from a two litre Winchester bottle through a rubber tube into the needle. This injection was continued only for thirty minutes, as the cow became too excited by the manipulation. The injection was carried out between 10:30 A.M. and 11:00 A.M., and during this time a total of 30 grams of glucose was injected.

At 11:30 A.M., 18.75 grams of glucose were injected intravenously in the ordinary way and this was followed by a final injection of 7.5 grams of glucose at 1:00 P.M. The results of Experiments 4, 5, 6, 7, and 8 are graphically illustrated in Figure 2, curves 2, 3, 4, 5, and 1 respectively, and are also accompanied by the protocols.

DISCUSSION OF RESULTS

Figure 1 illustrates graphically the hourly trend of milk sugar following the intravenous injection of glucose (curves 1 and 2) and the intraven-

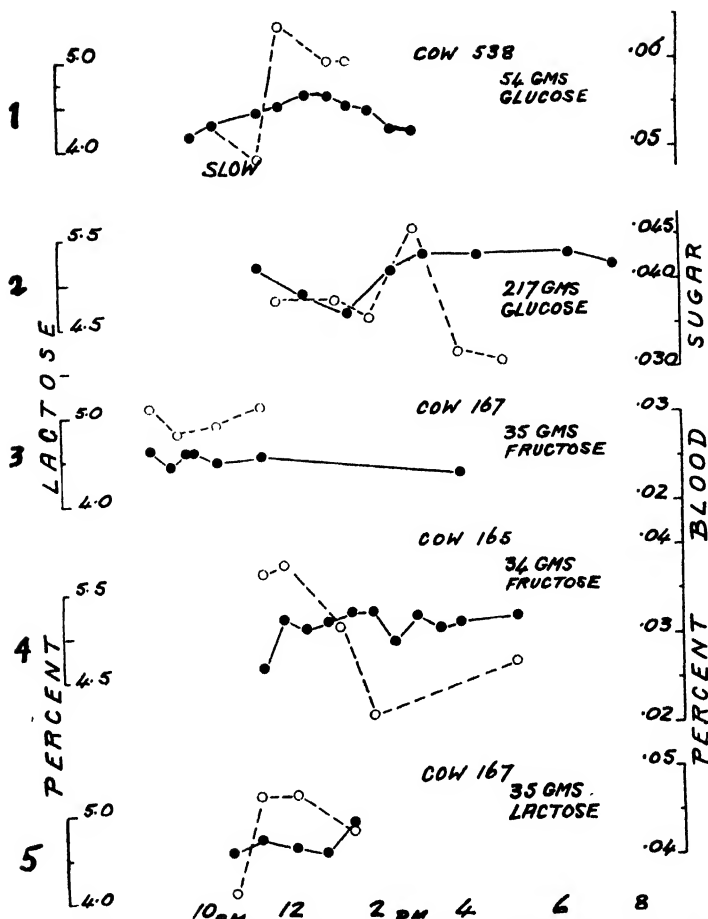


FIG. 2. Effect of intravenous injections of different sugars upon blood sugar level and the lactose content of milk.

—●— Lactose
- - - - -○- - - - - Blood sugar

Protocol. Curve 1.

Cow 538.

10:30 to 11:00 A.M. Slow injection of 30 gms. glucose.

11:30 A.M., 18.75 gms. glucose injected.

1:00 P.M., 7.5 gms. " "

10:30 A.M. Injected 2% novocain into ear and made several attempts to carry out a continuous slow injection of the glucose solution. The continuous manipulation around the animal's head, however, caused so much nervousness that the slow injection was discontinued. Immediately following the 11:30 A.M. glucose injection, a twitching started of the muscles over the whole of the body. This vigorous twitching continued for about 30 minutes, then gradually subsided. The animal was apparently normal when the 1:00 P. M. glucose injection was made, and except for a rise in temperature showed no further abnormal symptoms.

Protocol. Curve 2.

Cow 538.

11:45 A.M., 21.0 gms. glucose injected.

1:10 P.M., 59.5 gms. " "

2:00 P.M., 45.5 gms. " "

3:00 P.M., 91.0 gms. " "

No abnormal symptoms noticed.

Protocol. Curve 3.

Cow 167.

9:10 A.M., 17.5 gms. fructose injected.

9:50 A.M., 17.5 gms. " "

No abnormal symptoms noticed.

Protocol. Curve 4.

Cow 165.

11:40 A.M., 7.5 gms. fructose injected.

12:00 M., 7.5 gms. " "

1:30 P.M., 11.5 gms. " "

2:00 P.M., 7.5 gms. " "

No abnormal symptoms noticed.

Protocol. Curve 5.

Cow 167.

10:50 A.M., 35 gms. lactose injected.

No abnormal symptoms noticed.

ous injection of glucose (curve 3), as well as the milk sugar curves of the normal animals obtained within a day or so of the experiment.

It was thought that if a sugar injection actually resulted in an increased lactose secretion the lactose would be not only higher but also more constant in the successive hourly samples. While the curves obtained are higher than the normals, the marked fluctuations of all of them indicate that the apparent increase may be only accidental. No blood sugar determinations were run in these experiments, so further injections were made to see whether the blood sugar picture would help in the interpretation of results.

In the experiments graphed in Figure 2, both the blood and milk sugar fluctuations were determined. Some of these experiments are very short, as they were preliminary runs, the results of which were not considered promising enough to warrant more extended studies.

The blood sugar in curve 1 shows a marked decrease from 10:30 A.M. to 11:30 A.M., during which time 30 grams of glucose were slowly injected into an ear vein. It was at this low point that the instantaneous injection of 18.75 grams of glucose into the jugular vein apparently resulted in the tremors recorded in the protocol. Following this injection, hyperglucemia occurred.

In curve 2 the injections of glucose first caused a slight hypoglucemia, then a marked hyperglucemia, and finally a very pronounced hypoglucemia.

In curve 3 the first injection of fructose resulted first in a slight hypoglucemia, while the second injection had no immediate apparent result.

In curve 4, however, the fructose injection caused a very pronounced hypoglycemia of several hours' duration. The lactose injection depicted in curve 5 was the only one which resulted in a pronounced hyperglycemia.

The unexpected behavior of the blood sugar following intravenous sugar injections suggests that the apparent increase in the lactose secreted following some of the injections may be, as already mentioned, insignificant or due to some outside factor.

It has long been known that sugar ingestion in human beings results in first hyperglycemia followed by a pronounced hypoglycemia, then a gradual rise back to the normal level. Harrop and Benedict (3) who noted the above phenomenon offered the following tentative explanation: "It must be supposed that regulation of the output of pancreatic hormone is normally in some way governed by the amount of material awaiting metabolism. Ingestion of food high in carbohydrates should call out amounts of insulin adequate to metabolic requirements, and it would be expected that the effect of carbohydrate metabolism due to the natural hormone upon serum concentration would be similar to that produced by injection of the product prepared artificially." This suggestion seems to explain the results here reported, although the milk sugar curves do not follow the same downward trend that was noticed following the injection of large doses of insulin. A careful search of the literature has revealed a similar hypoglycemia following the injection of glucose in normal human beings, when Thalhimer, Raine, Perry and Butties (9) report that slow intravenous injections of 10 per cent glucose caused a rather severe hypoglycemia with results similar to a moderately severe insulin shock. The hypoglycemic effect produced by the intravenous injection of sugar solutions may be the cause of some of the results reported by other workers. While no adequate explanation can be offered to satisfy the already mentioned increased milk production obtained (by Piantoni, Sammartino, Monaco and coworkers, and Campus) upon the injection of small amounts of sugar, the decrease in volume due to the injections of large amounts of sugar as noted by Piantoni and Sammartino may be the result of a daily artificially induced hypoglycemic condition. In support of this suggestion there is the experimental work of Bucciardi (1) who found 5 or 6 successive insulin injections caused cessation of lactation in ewes, and our own experience in which cow 143 stopped lactating after its third insulin experiment.

CONCLUSIONS

Apart from the interesting hypoglycemic effects noted, the value of intravenous sugar injections in a study of lactose synthesis seems to be of very doubtful value, as the apparent slight success of Nitzescu might be easily caused by a hitherto unsuspected normal variation in the milk sugar of the goat of the same magnitude as we have found to frequently occur in

the lactating bovine. The reported success of Macchiarulo, on the other hand, is not supported by numerical data so must be neglected.

SUMMARY

1. Intravenous injections of glucose and fructose may result in a hypoglycemic condition in the bovine.

2. An intravenous injection of lactose resulted in a marked hyperglycemia.

3. A suggestion is offered to account for the decrease in milk secretion noted by many workers following daily injections of large amounts of sugar.

4. The intravenous injections of sugar are considered of doubtful value in the study of lactose synthesis.

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BITTER FLAVOR IN CHEDDAR CHEESE

WALTER V. PRICE

University of Wisconsin, Madison, Wisconsin

Bitter flavor is frequently found in Cheddar cheese. It may be only slightly apparent, or may actually make the product unpalatable. This defect has been observed by numerous workers, some of whom have been able to show specific causes for it. The typical citations which follow illustrate the variety of causes which have been indicated.

Publow (1) attributed bitter flavor in cheese to undesirable organisms, dirty cows, old starters and unclean or rusty milk cans. Allen (2) found it in cheese made from milk of inferior quality. He observed that alkali-forming and protein-splitting bacteria were present in larger numbers in the inferior milk than in clean milk, but that there was a marked tendency for the development of these organisms in the cheese made from clean milk, rather than in that made from inferior milk.

Some investigators believe that the defect can be traced to certain microorganisms. Hucker and Marquardt (3) were able to associate bitter flavor with *S. paracitrovorus* and certain strains of acid-proteolytic cocci. *S. paracitrovorus* in raw milk showed slightly bitter flavors after twelve weeks, which did not occur in cheese made from identical milk with Hansen's culture. In pasteurized milk *S. paracitrovorus* also showed slightly bitter flavor. Acid-proteolytic cocci gave a decidedly bitter flavor in two to three weeks which eventually made the cheese unpalatable. Riddet, Valentine, and Whitehead (4) described a bitter flavor which they produced by using a particular starter culture which had become a rather weak acid producer in the cheese vat. Bitter or metallic flavor was also found in the starter itself, as well as in the cheese. They added, however, that not all "slow" or bitter-flavored starters produce bitter cheese.

Riddet, Valentine and Whitehead (4), in reviewing the possible causes of bitter, flavor, observed that cheese made in their laboratory from normal milk, not overheated during pasteurization, frequently developed bitterness at an intermediate stage in the ripening process. The bitterness sometimes disappeared subsequently and the Cheddar flavor developed in an otherwise normal manner. This cycle had previously been observed by Allen (2) who noticed that bitterness in cheese made from inferior milk developed after four weeks and disappeared after sixteen weeks of curing. Kelly (5) commented on this sequence by stating that "many investigators who have studied the ripening processes in cheese have considered that the peptone

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stage of the decomposition of protein gave a characteristic bitter flavor to the curing cheese." Like the other workers, he indicated that, after 6 to 8 weeks of curing at temperatures higher than 10° C., a definite bitter stage was passed through before the final characteristic, mellow flavor was developed.

Pasteurized milk is frequently associated with bitter flavors, although those acquainted with the procedure usually attribute the defect to high temperatures of heating or to improper methods of curd making. Kneutinger (6) believed that excess whey in cheese made from pasteurized milk caused bitter flavor. Phillips (7) found the defect when milk was flash pasteurized to 177° F. Moir (8) noticed bitter flavors in cheese made from milk heated to 185° F.

In this laboratory the development of bitter flavors has been associated for the past few years with the use of certain starters and with the control of acidity during the curd making process. The defect seemed more apt to occur when the cheese showed a slight excess of acid development. It is understood that this relation has also been observed by workers in the laboratories of the United States Department of Agriculture, Bureau of Dairy Industry (9).

Phillips (10) has reported preliminary experimental results of work completed in this laboratory, which seem to show that development of acidities greater than pH 5.00 at 4 days after making, may contribute to the production of bitter flavor in Cheddar cheese.

EXPERIMENTAL

The manufacturing records from 178 lots of experimental cheese which were made in 1932 have been selected to study the relationship between bitter flavors and acidity of cheese. Commercial starter cultures were used and all lots of cheese were made from raw milk of average quality. Normal variations of the curd making process such as acidity of milk, size of cubes, temperature of cooking and the like, are represented in these data. No water, salts, except sodium chloride, or any other substances were added to the milk, whey or curd.

The methods used in measuring acidity in the cheese have been described elsewhere (11).

The criticisms of the cheese were made by competent judges who examined them two or three times during a curing period of approximately one year. The cheese were not scored frequently enough to indicate exactly when the bitter flavors first appeared or when they disappeared, as some undoubtedly did.

The quality of the cheese is indicated by numbers ranging from 1 to 6. The interpretation of these values may be briefly summarized as follows:

- 1—Excellent, no criticism.
- 2—Desirable.

3—Satisfactory commercial quality.

4—Objectionable.

5—Very undesirable.

6—Unmerchantable.

This system is used to indicate the rating of every cheese characteristic. The final grade of the cheese is the judge's estimate of the general quality on this same scale. It is not an average of the values awarded to flavor, body, texture, color and finish

RESULTS

The 178 lots of cheese are classified into five groups:—

- I. *Non-acid*. These lots were never criticised for bitterness or excessive acidity.
- II. *Bitter*. Bitterness was detected in every lot.
- III. *Trace-of-acid*. These lots showed only slight evidence of excessive acidity in flavor or body.
- IV. *Acid*. Some acid defect was clearly evident in each cheese of this group.
- V. *Sour*. These lots were very defective in flavor and body.

The quality of the cheese in each classification is indicated by the grades shown in Table 1. The average grades indicate that the best quality occurs in the non-acid group, while the worst quality appears in the sour group.

TABLE 1
Quality of cheese

CLASSIFICATION	NUMBER OF LOTS	AVERAGE GRADES		
		Flavor	Body	Final grade
Non-acid	40	$3.2 \pm .05$	$2.6 \pm .07$	$2.9 \pm .05$
Bitter	37	$3.4 \pm .04$	$2.9 \pm .04$	$3.4 \pm .04$
Trace-of-acid	32	$3.4 \pm .04$	$2.9 \pm .06$	$3.4 \pm .05$
Acid	36	$3.7 \pm .05$	$3.2 \pm .06$	$3.6 \pm .06$
Sour	33	$4.0 \pm .05$	$3.3 \pm .08$	$4.0 \pm .07$

The quality of the cheese in the acid and sour groups is inferior to that of the lots in the bitter and trace-of-acid classes. The interesting fact illustrated by the data in Table 1 is the similarity of quality of the cheese in the two latter classes.

The average of the pH measurements which were made when the cheese were three days of age, is shown in Table 2. The average pH of the non-acid group, $5.2 \pm .02$, is slightly greater than is commonly found in Cheddar cheese of commercial quality. The means of the bitter and trace-of-acid groups are $5.05 \pm .01$ and $5.07 \pm .02$ respectively, while the acid and sour groups have mean pH values of $4.98 \pm .02$ and $4.93 \pm .01$ respectively.

TABLE 2
Acidity of cheese

CLASSIFICATION	NUMBER OF LOTS	pH ON THIRD DAY AFTER MAKING	ACID DEVELOPMENT CUTTING TO DIPPING*	ACID DEVELOPMENT CUTTING TO MILLING**
Non-acid	40	5.20 \pm .02	1.79 \pm .08	3.70 \pm .09
Bitter	37	5.05 \pm .01	2.01 \pm .03	4.11 \pm .08
Trace-of-acid	32	5.07 \pm .02	2.34 \pm .09	4.34 \pm .09
Acid	36	4.98 \pm .02	2.23 \pm .08	4.27 \pm .12
Sour	33	4.93 \pm .01	2.70 \pm .18	4.33 \pm .13

* Acid development = $\frac{\text{pH at cutting} - \text{pH at dipping}}{\text{Minutes from cutting to dipping}} \times 1000.$

** Acid development = $\frac{\text{pH at cutting} - \text{pH at milling}}{\text{Minutes from cutting to dipping}} \times 1000.$

Approximately half of the bitter cheese at three days of age had pH values less than 5.03 which places them within the zone of acidity where acid defects may be expected (11). As a matter of fact, four-fifths of the bitter cheese were actually criticised by the judges for excessive acidity. The variability of the data is pictured graphically in figure 1. Cumulative curves have been drawn to show the percentage distribution of the lots of four classes according to the pH of the cheese, measured three days after making.

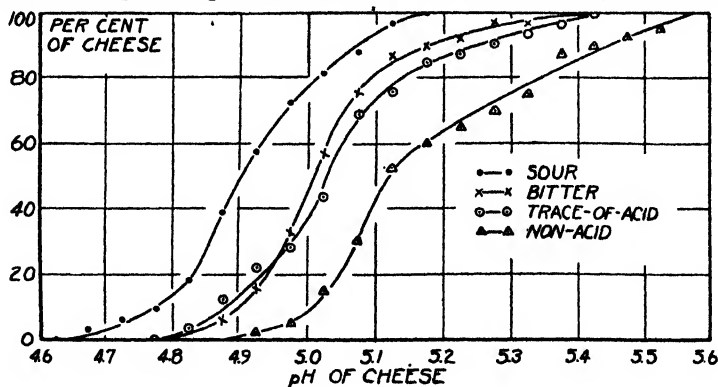


FIG. 1. Cumulative frequency curves showing the distribution of the lots of cheese in the Sour, Bitter, Trace-of-acid and Non-acid groups according to the pH measured at three days of age.

These curves clearly indicate the tendency of the cheese of the non-acid to fall in a more alkaline range than the cheese of the sour group. The curves representing bitter cheese and cheese with a trace of acid are notably similar and fall approximately midway between the two extreme classes. These curves indicate that approximately 20 per cent of the cheese samples in the non-acid class had an average pH of less than 5.05 on the third day after making, while about 85 per cent of the sour, 65 per cent of the bitter, and

60 per cent of the trace-of-acid groups had average pH values of less than 5.05 at this same age.

The rates of acid development from cutting to dipping and cutting to milling are shown in Table 2. It is usually recognized that rapid increase in acid may be responsible for defects associated with excessive acidity. The average rates of acid development in the bitter cheese from cutting to dipping and from cutting to milling, fall between the average values of the non-acid and acid-defective cheese, but approach more closely those of the latter groups.

Moisture content of curd at dipping is an indication of "firmness." Curd must be firm and without excessive acid development at dipping in order to be reasonably safe from acid defects. The average moisture contents of the cheese in each of the five groups at dipping are shown in Table 3. The differences between these means are too small to be of any great significance in distinguishing between the classes. Apparently the moisture content of bitter

TABLE 3
Moisture in cheese

CLASSIFICATION	NUMBER OF LOTS	MOISTURE IN CURD AT DIPPING	MOISTURE IN CHEESE AFTER THREE DAYS
Non-acid	40	60.3 \pm .4	37.3 \pm .2
Bitter	37	60.2 \pm .4	37.0 \pm .1
Trace-of-acid	32	59.6 \pm .5	36.7 \pm .2
Acid	36	59.6 \pm .4	37.0 \pm .2
Sour	33	59.7 \pm .6	37.6 \pm .3

cheese approximates that of low-acid cheese during the early stages of curd-making more closely than it does that of the high-acid type.

Cheese composition three days after making reflects the effects of mechanical treatment and acid development on moisture. The data in Table 3 show fairly low average moisture contents in the cheese of each group. Differences between groups are small, however, considering the variability indicated by the probable errors of the means. Apparently moisture content of the curd at dipping and of the cheese three days after making is not a means of distinguishing bitter cheese from either low- or high-acid cheese.

DISCUSSION

The bitter cheese and cheese with a trace of acid considered in these data have several characteristics in common. Judges found that the two groups had approximately equal quality values which made them less desirable than low-acid cheese, but superior to the high-acid products. The similar acidity attained by these two groups three days after making placed them again between the values of the extremes. The rate of acid development in the cheese of the bitter group was definitely greater than in the low-acid group, but less than any of three acid-defective groups.

It seems possible, after considering these similarities, to believe that bitterness in cheese may be associated with a slight over-acid-development. The development of high acidity in cheese may be caused by using milk in which too much acid has been permitted to develop, either on the farm or in the factory. Occasionally this over-development of acid may be caused by the use of a very active starter. Such factors also may be partly responsible for the development of too much acidity during the curd-making process. Many operators use such means to encourage high development of acidity in order to shorten the process of making. Over-development of acid during the manufacturing operations has been associated with a low pH in cheese which is three days old (11). Study of data from nearly 200 lots of American cheese showed that the pH measurements at cutting, dipping, and milling were related to the pH of the cheese at three days of age by coefficients of correlation of +.50, +.54 and +.70, respectively (12). It seems highly probable that limiting acidity development during the curd-making operations should afford an excellent means of reducing the incidence of bitter cheese.

CONCLUSION

Bitter flavor in cheese seems to be associated with the development of a slightly excessive amount of acidity.

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A STUDY OF FAT SPLITTING AND CASEIN DIGESTING BACTERIA ISOLATED FROM BUTTER

C. N. STARK AND B. J. SCHEIB

*Laboratory of Bacteriology, New York State College of Agriculture,
Cornell University, Ithaca, N. Y.*

It has long been assumed, (Hagemann), (1) that rancidity in butter is due to free butyric acid, and Richmond (2) stated that rancidity is due to the hydrolysis of fat, resulting in the presence of free volatile fatty acids. However, Schmid (3), Amthor (4), Hanus (5), Reinmann (6), Orla-Jensen (7), Sayer, Rahn, and Farrand (8), Rahn, Brown and Smith (9), and others, found that no relationship existed between rancidity in butter and the presence of free fatty acids as determined by titration methods.

Since no correlation exists between acidity and rancidity in butter, it might appear that no relation should exist between hydrolysis of fat and rancidity in butter. However, it seems highly probable that the amounts of butyric acid present in rancid butter are so small that, though they can be detected by the flavor and odor of the butter, they cannot be measured by ordinary chemical means.

Guthrie (10) stated, "A small amount of butyric acid gives the characteristic odor of rancidity. A strong solution of butyric acid does not give so characteristic a flavor of rancidity as may often be found in butter."

Holm and Greenbank, in the *Fundamentals of Dairy Science* by Associates of Rogers (11) say, "Milk fat, on account of its relatively high percentage of the lower fatty acids, especially butyric, readily produces a strong odor characteristic of these acids, upon slight hydrolysis."

This condition would tend to explain the negative correlation between acidity and rancidity in butter observed by workers in this field.

It has long been known that certain microorganisms can hydrolyze the fat in butter. Thus Escherich (12) stated that bacteria are able to split neutral fat to glycerol and free fatty acids, and Lafar (13) isolated two species of bacteria which produced rancidity in cream. Orla-Jensen obtained rancidity by cultivating pure and mixed cultures of organisms in butter, while Rogers (14) studied a *Torula* from butter which had a weak lipolytic action. Reitz (15) observed the fat splitting properties of certain bacteria, yeasts and molds. Collins (16), Hussong (17), and Hammer and Collins (18) studied fat splitting bacteria isolated from butter and the relationship of their presence in butter to its keeping quality. Since the presence of fat splitting bacteria may be of significance in the keeping qualities of butter, a detailed study has been made of 375 pure cultures of

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fat hydrolyzing bacteria isolated from butter produced and held under known and controlled conditions.

The butters used in these investigations were made under the personal supervision of Prof. E. S. Guthrie.

Turner (19) found that a Nile blue sulfate medium containing fat was highly sensitive for the detection of fat splitting organisms. The toxicity of Nile blue sulfate was found by him to inhibit the growth of some organisms. In this study its toxicity has been reduced by having the Nile blue sulfate in solution only in the fat.

The method employed in reducing the toxicity of Nile blue sulfate was developed by Prof. Georges Knaysi and has been used in his classes for several years.

The hydrolysis of milkfat by bacteria might bear little relationship to rancidity unless tributyrin were hydrolyzed producing butyric acid which is recognized as the substance necessary for the presence of rancidity in butter. The tributyrin splitting capacity of the cultures reported in this study has been determined. Anderson (20) has used a tributyrin agar for the detection of lipolytic organisms. This medium, with a few minor changes in its composition, was used by us.

It is recognized that the presence of organisms in butter capable of decomposing the casein are of importance in the deterioration of butter. Eckles (21) reported the case of a putrid butter due to proteolytic bacteria. Sayer, Rahn, and Farrand (8), and Sohgen (22), stressed the possibility of the production of strongly tasting and smelling compounds from the splitting of nitrogenous compounds in butter. Hunziker, Spitzer, Mills, and Switzer (23) suggested that protein hydrolysis may be responsible for off flavors in butter. Another investigator (24) concluded that increases in the proteolytic types of bacteria were one of the undesirable factors in butter. Sutton (25) believed that odors due to changes in the protein were a reliable indication of biological activities in butter. Spitzer and Parfitt (26) found that the score of the butter decreased as the growth of proteolytic bacteria increased. Ruehle (27) claimed that metallic flavors were due to protein decomposition products. Nelson (28) reported that protein decomposition was a very common defect in butter.

Proteolytic bacteria were studied to determine if any relationship existed between the ability of the organisms to split fat, split tributyrin, and decompose the casein of milk. Using these three properties as criteria of organisms capable of producing changes detectable by the presence of off flavors and odors in butter, this study has been made.

METHODS

Using sterile triers, portions of butter were placed into sterile test tubes which were held in a water bath at 45° C. until the butter was melted. After

mixing the contents of the tube a 1 cc. portion was removed with a pipette and placed into a sterile water blank from which triplicate agar plates were made. All materials used were warmed to 45° C. previous to use.

In pouring the plates, three agars were used. For the detection of organisms capable of hydrolyzing milk fat, the following agar was used:—

0.5 per cent beef extract
0.5 per cent yeast extract
0.5 per cent peptone
0.5 per cent glucose
1.5 per cent agar
Distilled water
pH 7.0

The agar was placed into bottles, each containing about 120 cc. Before pouring the plates, the agar was cooled to 45° C., one cc. of butter fat stained with nile blue sulfate was added and the bottle was shaken well to distribute the fat in fine globules throughout the agar. The butter fat to be stained with nile blue sulfate was melted, decanted, and placed in a large separatory funnel, and washed five or more times with hot water. A hot aqueous 5 per cent solution of nile blue sulfate was added to the butter oil in the proportion of one part nile blue sulfate to nine parts butter oil. When these materials were well mixed, and the fat had taken on a dark red color, the aqueous layer was removed and the fat washed five or more times with hot water until the water washings were free from any blue color. The fat was filtered through paper, decanted from any remaining water, tubed in 10 cc. portions and sterilized at 121° C. for 30 minutes.

The agar plates were incubated at room temperature for one week. Organisms capable of splitting the milkfat were detected by the appearance of blue or blue green granules beneath and around the colony. When the milkfat is hydrolized and the resulting fatty acids are liberated, the neutral red color of the nile blue sulfate in the presence of these fatty acids is changed to a blue or blue green. Well isolated fat splitting colonies were picked from these agar plates into a medium of the following composition:—

0.5 per cent beef extract
0.5 per cent yeast extract
0.5 per cent peptone
0.5 per cent glucose
Distilled water
pH 7.0

This broth was used throughout this study as a stock medium for preparing the cultures for various tests.

For the detection of organisms capable of hydrolyzing tributyrin, a medium of the same composition was used for plating, except that glucose

was omitted. Previous to pouring the plates, one cc. of sterile tributyrin (Eastman-Kodak Co. C. P.) was added to the agar, which was well shaken to distribute the oil evenly throughout the agar. The plates were incubated at room temperature for one week. The organisms capable of splitting tributyrin were detected by the presence of a clear zone around the colony distinguished from the opaque emulsified tributyrin in the rest of the agar. Upon the hydrolysis of the insoluble tributyrin, butyric acid and glycerol are formed, these compounds being soluble in the agar. The tributyrin splitters were picked into a broth of the same composition as that used for the isolation of the fat hydrolyzing bacteria.

For the detection of organisms capable of decomposing the casein in milk, an agar medium of the same composition as that used for the fat splitters was employed, the fat being omitted, and five cc. portions of sterile milk added to each bottle of agar just before pouring the plates. These agar plates were held for one week at room temperature. The milk plates were opaque and cloudy in appearance and proteolytic organisms were detected by the presence of a clear zone around the colony not becoming turbid when the agar was acidified by flooding the surface of the agar with tannic acid. Well isolated colonies were placed directly into litmus milk which was held for two weeks in order to confirm their action on casein.

To determine the relationship between the ability of the organisms to split fat, split tributyrin, and decompose the casein in milk, each culture isolated was streaked upon all of the three agars used in this study.

Motility tests were determined from hanging drop preparations of actively growing cultures. From agar slope cultures, the gram reaction of the organisms was determined using Burke's (29) modification of the gram staining technique. These microscopic examinations also furnished additional confirmation of the purity of the cultures being studied.

Acid and gas production from certain carbohydrate materials was determined by inoculation into standard nutrient broth, to which had been added 0.5 per cent of the carbohydrate, contained in Durham tubes. To aid in classifying the aerobic spore-producing rods, their activity on starch was determined by streaking upon a starch agar consisting of nutrient agar to which had been added 0.2 per cent water soluble starch. Each culture was tested for its ability to liquefy gelatin. Cultures grown in peptone broth were tested with Nessler's reagent for ammonia production, and with Ehrlich's reagent for the production of indol. Ability to reduce nitrates was determined by inoculating nitrate broth contained in Durham tubes. The presence of nitrites was detected by using Trommsdorf's reagent and further reduction by the presence of gas in the inverted vial.

Precautions were taken to be certain that all the test media were inoculated with vigorously growing cultures. In all the tests for the activity of these organisms on various substances, a two weeks holding period at room temperature was employed.

Temperature limits of growth of all the organisms studied were determined by inoculation into a medium of the following composition :—

0.5 per cent beef extract
0.5 per cent yeast extract
0.5 per cent peptone
0.1 per cent glucose
Distilled water
pH 7.0

Immediately after inoculation the temperature of the broth was adjusted to the conditions under which it was to be incubated for two weeks.

Representatives of each group studied were tested for the ability to withstand a temperature of 62.8° C. (145° F.) for 30 minutes. One cc. of a 24-hour broth culture was placed into the bottom of a sterile test tube, precautions being taken not to let any of the broth culture touch the side of the test tube. Nine cc. of sterile silk were carefully added with a pipette in such a manner as to mix the contents of the tube. The cotton plugs were replaced with sterile rubber stoppers to avoid the cooler temperatures which would prevail at the surface of the liquid during the heating period if evaporation were allowed to take place. The tubes were placed in a constant temperature water bath which had been held at 62.8° C. (145° F.) for four hours previous to testing the cultures. The temperature did not vary more than $\pm 0.1^\circ$ C. during the holding period. After being subjected to this temperature for 30 minutes, the tubes were immediately cooled in ice water and the rubber stoppers replaced with cotton plugs. In all cases, growth in the pasteurized milk was detected by streaking agar slopes from the milk at the end of one and two weeks of incubation at room temperature. Casein digesters which survive the heating process could also be detected by their action upon the milk. All organisms surviving the heat treatment were retested.

EXPERIMENTAL

The groupings which have been made in this study are based upon Bergey's (30) classification. The activity of these organisms on milkfat and tributyrin has been included.

Of the organisms isolated, 188 were found to be gram negative rods (Tables 1 and 1a), of which eleven were members of the *Escherichia*-*Aerobacter* group. Forty cultures which resembled *Pseudomonas aeruginosa* in physiological properties have been studied. Thirty of these cultures produced a blue-green pigment soluble in water, turning to a dark brown with age, and becoming red in the presence of acid. In testing for indol production a red color was produced but it was insoluble in chloroform, in this way differing from Bergey's description of this species. The other ten cultures were identical in all respects with the above type except that

TABLE 1
Some physiological properties of certain gram negative rods isolated from butter

NAME OF ORGANISMS	NUMBER OF CULTURES	MOTILITY	ACTION ON LITMUS MILK				LIQUEFACTION OF GELATIN	HYDROLYSIS OF MILKFAT	HYDROLYSIS OF TRIBUTYRIN	ACTION ON SUGARS			REDUCTION OF NITRATES	AMMONIA FROM PEPTONE	INDOL FROM PEPTONE	TEMPERATURE LIMITS OF GROWTH											
			Digestion	Curd	Acid	Alkaline				Reduction of litmus	Glucose	Lactose				Sucrose											
<i>Pseudomonas aeruginosa</i> , variant	30	+	+	-	-	-	+	+	+	-	-	-	⊕	+	-	+	5° C.	+	+	+	+	+	+	+	+	+	+
<i>Achromobacter pelliculum</i>	10	+	+	-	-	-	+	+	+	-	-	-	⊕	+	-	-	+	+	+	+	+	+	+	+	+	+	+
<i>Achromobacter pelliculum</i> , variant	37	+	+	-	-	-	+	+	+	-	-	-	+	+	-	-	+	+	+	+	+	+	+	+	+	+	+
<i>Achromobacter aromaciens</i>	16	+	+	sl.*	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
<i>Achromobacter</i> Sp.	18	+	+	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
<i>Achromobacter</i> Sp.	3	+	+	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
<i>Achromobacter</i> Sp.	4	±	+	-	-	-	sl.	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
<i>Alcaligenes bookeri</i> (I)	23	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
<i>Alcaligenes bookeri</i> (II)	7	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
<i>Alcaligenes bookeri</i> (III)	10	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
<i>Alcaligenes fecalis</i>	6	+	+	-	-	-	±	-	±	+	±	±	+	+	+	+	+	+	±	±	±	±	±	±	±	±	±
<i>Alcaligenes fecalis</i> , variant	6	+	-	-	-	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
<i>Flavobacterium synsaccharum</i>	4	+	+	+	-	-	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
<i>Flavobacterium</i> Sp.	3	+	+	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

* sl. = slight.

TABLE 1a
Some physiological properties of members of the *Escherichia-Aerobacter* group isolated from butter

NAME OF ORGANISMS	NUMBER OF CULTURES	MOTILITY	ACTION ON LITMUS MILK					LIQUEFACTION OF GELATIN	HYDROLYSIS OF MILKPEAT	HYDROLYSIS OF TRIBUTYRIN	ACTION ON CARBOHYDRATES					METHYL RED TEST	INDOL FROM PEPTONE	REDUCTION OF VITAMINS	AMMONIA FROM PEPTONE	TEMPERATURE LIMITS OF GROWTH				
			Digestion	Curd	Acid	Alkaline	Reduction of litmus				Glucose	Lactose	Sucrose	Saltin	Indol					5° C.	10° C.	15° C.	50° C.	
<i>Aerobacter cloacae</i>	8	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
<i>Intermediate Sp.</i>	1	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
<i>Intermediate Sp.</i>	1	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
<i>Escherichia Sp.</i>	1	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

⊕ = acid and gas.

they produced a yellow-green pigment slightly soluble in water, the color of which did not change with age or in the presence of acid. Under the same conditions no blue pigment was produced by these cultures. This group was assumed to be a variant of *Pseudomonas aeruginosa*. All 40 cultures hydrolyzed milkfat and tributyrin and digested the casein of milk.

Another large group studied consisted of 53 cultures which resembled *Achromobacter pellucidum*. Thirty-seven of the cultures were true to the described type but the remaining 16 cultures were able to reduce nitrates. This entire group was active on milkfat, tributyrin, and the casein of milk.

Eighteen cultures resembling Bergey's description of *Achromobacter aromafaciens* were studied. The cultures described in this work were motile, whereas Bergey reports the type species as non-motile. These cultures were active on milkfat and tributyrin, and exhibited a slight action upon the casein of milk.

Three cultures slightly resembled *Achromobacter lipolyticum* and were active on milkfat and tributyrin and peptonized the casein of milk. These cultures were unable to ferment maltose, sucrose, glycerol and mannitol, thereby differing from Bergey's description of the species. *Achromobacter* sp. consisted of four cultures, two of which were motile, produced ammonia, and acted on fat; all acted on tributyrin and none digested casein.

Another group of 40 cultures resembling Bergey's description of *Alcaligenes bookeri* really consisted of three separate groups. Twenty-three of the cultures definitely reduced the litmus in litmus milk which the remaining 17 cultures did not do. Thirty of the 40 cultures did not reduce nitrates. Bergey's statement regarding the reduction of nitrates by *Alcaligenes bookerii* is vague and indefinite. Some similarity can be noticed between *Alcaligenes bookerii* and *Achromobacter aromafaciens*, the major difference being in the extent to which the casein of milk was digested, and the temperature limits of growth. *Achromobacter aromafaciens* is exceptional because of its inability to grow at 37° C. All of these cultures were active on milkfat and tributyrin, and peptonized the casein of milk.

The *Alcaligenes fecalis* group consisted of 12 cultures which agreed closely with Bergey's description. Six of the cultures differed from the type species in being nonmotile and are referred to as variants. Ten of the cultures isolated were able to split milkfat, all 12 split tributyrin, and none were active on the casein of milk.

Seven of the gram negative rods studied produced a yellow pigment. The first group, *Flavobacterium synzanthum*, consisting of four cultures, was active on tributyrin and the casein of milk, but was unable to split milkfat. *Flavobacterium* sp. split tributyrin and did not attack the milkfat or the casein of milk.

Of the eleven cultures of gas producing gram negative rods belonging to the *Escherichia-Aerobacter* group, none was able to attack the casein

of milk. Eight cultures, identified as *Aerobacter cloacae*, split tributyrin but were unable to attack the milkfat. The *Escherichia* sp. and the two intermediates were active on tributyrin, only one of which was able to split milkfat.

Of the 188 cultures of gram negative rods here reported, only the *Flavobacterium synxanthum* cultures were able to survive pasteurization at 62.8° C. (145° F.) for 30 minutes. Certain cultures of blue pigment producing *Pseudomonas aeruginosa* showed on holding a slow peptonization of the pasteurized milk, but when streaks were made upon agar slants from the milk, no growth occurred. This observation indicated the presence of proteolytic enzymes which were not destroyed by the heat treatment. The enzyme-protecting effect of soluble proteins has also been observed by Virtanen and Tarnanen (31).

Eighty-four per cent (158) of the 188 cultures of gram negative rods studied digested milk, 89 per cent (167) split fat, and 100 per cent (188) hydrolyzed tributyrin. Of the 158 cultures which proteolized milk, 97 per cent also split fat. It might be significant to mention that though all of these 158 cultures were able to split tributyrin, 47 per cent of them were isolated on the basis of their ability to split fat, 30 per cent because of their power to digest casein, and the remaining 23 per cent for their ability to hydrolyze tributyrin. Another fact of importance is that these organisms, all of which were isolated from sweet cream, unsalted butter, were present in many millions per gram. Such large numbers are recognized as significant (32), (33).

A study has been made of 214 cultures of cocci, of which 151 were gram positive micrococci, 40 gram negative micrococci, and 23 gram positive sarcina. Because of the incomplete descriptions of the characteristics of the organisms recorded in Bergey's Manual, it is difficult to be certain of the names under which these organisms should be reported. It has been felt better to use names in the instances where the number of cultures having like properties was large. When possible, previously used names have been employed. In five instances, the reactions given by the groups of cultures studied were so outstanding, yet so different from previously recorded descriptions, that new names are believed justified.

Some of the physiological properties of 40 cultures of gram negative cocci occurring singly, in pairs, or irregular masses, are recorded in Table 2. The outstanding characteristic of all of these cultures is their ability to hydrolyze fats. Since the findings recorded in the literature did not describe these organisms, it is suggested that the type species of the group be called *Micrococcus lipolyticus* n. sp. All of the cultures attacked both fat and tributyrin, but were unable to digest casein. The source of these organisms was sweet cream, unsalted butter. None was able to survive pasteurization at 62.8° C. (145° F.) for 30 minutes. Since these organisms were found in butter in millions per gram, they are probably of significance in its spoilage.

TABLE 2
Some physiological properties of *Micrococcus lipolyticus* and certain related species

NAME OF ORGANISMS	NUMBER OF CULTURES	ACTION ON LITMUS MILK					LIQUEFACTION OF GELATIN	HYDROLYSIS OF MILK-CASEIN	HYDROLYSIS OF TRYPTOPHAN	ACTION ON SUGARS			REDUCTION OF NITRATES	AMMONIA FROM PEPTONE	INDOL FROM PEPTONE	TEMPERATURE LIMITS OF GROWTH																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
		Digestion	Curd	Acid	Alkaline	Reduction of litmus				Glucose	Lactose	Sucrose				5° C.	10° C.	Room	37° C.	40° C.	45° C.	50° C.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
<i>Micrococcus lipolyticus</i>	22	+	+	+	+	sl.	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

sl. = slight.

w = weak.

TABLE 3
Some reactions given by *Sarcina caseolytica* and certain related species

NAME OF ORGANISMS	NUMBER OF CULTURES	ACTION ON LITMUS MILK						LIQUEFACTION OF GELATIN	HYDROLYSIS OF MILKCASEIN	HYDROLYSIS OF TRYPTOPHAN	ACTION ON SUGARS			REDUCTION OF NITRATES	AMMONIA FROM PEPTONE	INDOL FROM PEPTONE	TEMPERATURE LIMITS OF GROWTH					PIGMENTATION
		Digestion	Curd	Acid	Alkaline	Reduction of litmus	Glucose				Lactose	Sucrose	5° C.				10° C.	40° C.	45° C.	50° C.		
<i>Sarcina caseolytica</i> N. Sp.	14	+	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	white
<i>Sarcina caseolytica</i> , variant	4	+	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	white
P 28	1	+	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	white
P 95	1	+	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	white
T 108, 109	2	-	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	white
C 27	1	-	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	white

Twenty-three of the isolations made were gram positive organisms belonging to the *Sarcina* genus (Table 3). Fourteen of the cultures were similar in all the physiological properties tested, and were very active on the casein of milk. The only milk digesting sarcina listed in Bergey's Manual is *Sarcina aurantiaca* which differed from the cultures here reported in pigment production, nitrate reduction, indol production and sugar fermentations. Since these organisms occurred in butter in large enough numbers to be of significance in its keeping quality, and since their most outstanding physiological property was their active digestion of casein in milk, it was decided to suggest for them the name *Sarcina caseolytica* n. sp. Four other cultures varied from the type species only in their inability to ferment sucrose. None of these 18 cultures were able to hydrolize either fat or tributyrin. Five other cultures of sarcina, the physiological reactions of which are reported in Table 3, varied from the type species in other respects. None of these cultures were able to survive pasteurization at 62.8° C. (145° F.) for 30 minutes. The source of these organisms was salted and unsalted, raw cream butter. Difficulty was experienced in keeping these cultures alive.

Thirty-eight of the gram positive micrococci cultures studied (Table 4) were morphologically different from any of the species previously described in the literature. These cultures when aged were definitely micrococci, but in their early stages of growth were distinctly rod-like to such an extent that one might mistake them for short oval rods. The physiological properties of these organisms were very similar to those of *Micrococcus lipolyticus* but due to the difference in the gram reaction and their variable morphology, the name *Micrococcus intermedius* n. sp. is offered. Twenty-six of the cultures were alike and produced a moist, light yellow growth on agar slopes, caused litmus milk to become alkaline, failed to reduce nitrates, and were active in the hydrolysis of milkfat and tributyrin. Six other cultures in this group varied from the type species only in their action upon milk, or nitrates, or milkfat. Six miscellaneous cultures were morphologically related to the type species but were physiologically more variable.

Fifty-three medium-sized gram positive micrococci, occurring in irregular clumps, have been studied. Twenty of the cultures were alike and resembled *Micrococcus flavus* except that the cultures here reported reduced nitrates. Five other cultures in this group were similar to *Micrococcus freudenreichii* except that these cultures produced a light yellow pigment. The variants of both *Micrococcus flavus* and *Micrococcus freudenreichii* were active in the hydrolysis of milkfat and tributyrin and in the digestion of casein, which may be indicative of their importance in the spoilage of butter. The remaining 28 miscellaneous cultures varied in other respects. These results are summarized in Table 5.

TABLE 4
Some of the reactions given by *Micrococcus intermedius* and some related species

NAME OF ORGANISMS	NUMBERS OF CULTURES	PIGMENTATION	ACTION ON MILK					DIGESTION OF GELATIN	HYDROLYSIS OF MILKCASEIN	HYDROLYSIS OF TRYPTOPHAN	ACTION ON SUGARS			REDUCTION OF NITRATES	AMMONIA FROM PEPTONE	INDOLE FROM PEPTONE	TEMPERATURE LIMITS OF GROWTH									
			Digestion	Curd	Acid	Alkaline	Reduction of litmus				Glucose	Lactose	Sucrose				5° C.	10° C.	15° C.	17° C.	40° C.	45° C.	50° C.			
<i>Micrococcus intermedius</i> N. Sp.	26	light yellow	-	-	-	+	-	-	+	+	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+
<i>Micrococcus intermedius</i> , variant	3	light yellow	-	-	-	-	-	-	+	+	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+
<i>Micrococcus intermedius</i> , variant	1	light yellow	-	-	-	+	-	-	-	+	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+
<i>Micrococcus intermedius</i> , variant	1	light yellow	-	-	-	-	-	-	+	+	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+
<i>Micrococcus intermedius</i> , variant	1	yellow	-	-	-	-	-	-	+	+	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+
<i>Micrococcus intermedius</i> , variant	2	deep orange	-	-	-	+	-	-	+	+	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+
T 227, 228	1	light yellow	-	-	-	-	-	-	-	+	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+
T 269	1	light yellow	-	-	-	-	+	-	-	+	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+
T 226	1	light yellow	-	-	-	-	-	+	-	+	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+
F 248	1	pale yellow	-	-	-	+	-	-	+	+	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+
P 220	1	pink	-	-	-	-	-	-	+	+	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+

TABLE 6
The physiological reactions of some large gram positive Micrococci isolated from butter

[illegible]

The remaining gram positive micrococci (Table 6), consisting of 60 cultures, were very large spherical forms occurring singly or in irregular masses. One of the noticeable properties of these cultures was the difficulty experienced in keeping them alive. A gram stained preparation from an agar slope would invariably show many gram negative cocci in each microscopic field, probably indicating that these organisms were dead. Eight of these cultures resembled *Micrococcus caseolyticus* except that they produced a yellow pigment. Twenty-one other cultures in this group produced acid and slight reduction in litmus milk, and hydrolyzed tributyrin. Since the reactions of these organisms were not found in any of the recorded descriptions, and since no outstanding physiological property was noted, and because their morphology was distinct, the name *Micrococcus magnus* n. sp. has been used. Five other cultures caused no change in litmus milk, and no action on the milkfat or the carbohydrates tested. Since these cultures, although few in number, appeared to be both distinct and different from any other description reported, a new name seemed necessary. Because these cultures were isolated from butter, and also their action in hydrolyzing tributyrin may indicate their importance in the spoilage of butter, the name *Micrococcus tributyrus* n. sp. is suggested. The reactions of the remaining 26 miscellaneous cultures are shown in Table 6. No further classification has been attempted.

None of the 214 cultures of cocci studied were able to survive pasteurization at 62.8° C. (145° F.) for 30 minutes. The predominant source from which these cocci were isolated was sweet cream, salted and unsalted butter, although a few isolations were made from sour cream butter. With the exception of the gram negative micrococci and sarcina groups, of which previous mention has been made, the cocci here reported did not occur in sufficiently large numbers in butter to be of great importance in its spoilage.

Ten cultures of gram positive nonsporeproducing rods (Table 7) have been studied. Six of these cultures (Group A) are short, thin, slender rods occurring singly or in short chains. On ordinary agar media they produced an abundant, moist, white growth. Litmus milk was reduced and peptonized, both milkfat and tributyrin were hydrolyzed, and none of the carbohydrates tested was fermented. Growth occurred at 5° C. but not at 37° C. These organisms were present in butter in large enough numbers to be of possible significance in its spoilage, but since they were observed in only one sample of butter, their importance might be questioned. No name is suggested. Four other miscellaneous cultures of gram positive nonsporeproducing rods were studied (see Table 7).

Of 74 gram positive, aerobic, sporeproducing rods studied (Table 8), 34 cultures were identified as *Bacillus mesentericus*. The typical organism of this group is very active in the liquefaction of gelatin and the digestion of milk, ferments glucose and sucrose, and does not hydrolyze starch or reduce

TABLE 8
Some physiological properties of gram positive spore producing rods isolated from butter

NAME OF ORGANISMS	NUMBER OF CULTURES	MOTILITY	ACTION ON LITMUS MILK					LIQUEFACTION OF GELATIN	HYDROLYSIS OF MILKFAT	HYDROLYSIS OF TRIBUTYRIN	ACTION ON CARBOHYDRATES				REDUCTION OF NITRATES	AMMONIA FROM PEPTONE	INDOL FROM PEPTONE	TEMPERATURE LIMITS OF GROWTH																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
			Digestion	Curd	Acid	Alkaline	Reduction of litmus				Glucose	Lactose	Sucrose	Starch				5° C.	10° C.	15° C.	37° C.	40° C.	45° C.	50° C.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
<i>Bacillus mesentericus</i>	34	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

w = weak.

nitrates. Previous studies have not reported the action of these organisms on milkfat or tributyrin. These 34 cultures were very active in the hydrolysis of these fats. Twenty-eight of the cultures studied resembled the morphological description reported for *Bacillus centrosporous* but differed materially in cultural characteristics and physiological properties from any description recorded by Bergey. These organisms were also active in the digestion of casein and the splitting of milkfat and tributyrin. Ten other cultures were identified as *Bacillus parvus*, *Bacillus agri*, *Bacillus laterosporous*, *Bacillus simplex*, *Bacillus mycoides*, *Bacillus cereus*, *Bacillus ruminatus*, *Bacillus peptogenes*, and *Bacillus subtilis*. Two unidentified cultures were found.

With one exception, these 74 cultures were active in splitting milkfat and tributyrin and digesting casein. Although the presence of large numbers of these organisms in butter would obviously be harmful, the numbers found in the samples tested in this study were never large enough to indicate significant growth of these organisms in butter. Since they were never present in numbers greater than a few hundred to a few thousand per gram of butter, they would seem to be of no practical importance in its deterioration. It is believed, however, that large numbers of such organisms present in the cream previous to the making of the butter would affect its keeping quality.

DISCUSSION

In this investigation, agar containing fat, tributyrin, or milk has been used in determining both total and differential counts of micro-organisms present in samples of butter made and held under known and controlled conditions. From these butters, 486 pure cultures have been isolated on the basis of their ability to hydrolyze fat, or split tributyrin, or digest casein. Thirty-eight per cent (183 cultures) were isolated from milkfat agar, 36 per cent (174 cultures) from tributyrin agar, and 26 per cent (129 cultures) from milk agar. A study of the cultures showed 96 per cent (467 cultures) were tributyrin positive, 77 per cent (375 cultures) were fat positive, and 63 per cent (306 cultures) were proteolytic on milk.

Of the 486 cultures reported in this study, 188 were gram negative rods, 40 were gram negative micrococci, 23 were gram positive sarcina, 151 were gram positive micrococci, 10 were gram positive nonsporeproducing rods, and 74 were gram positive aerobic sporeproducing rods.

Those present in large enough numbers to be of importance in the spoilage of butter were gram negative rods, gram negative micrococci, gram positive sarcina and gram positive nonsporeproducing rods. Of these groups which occurred in large numbers, only the gram negative rods were regularly present in all of the butters tested. One hundred fifty-eight or 84 per cent of the cultures of gram negative rods were able to digest casein in milk agar. Since 97 per cent (154 cultures) of these organisms hydrolyzed

fat, and all of them split tributyrin, it would seem that the presence of casein-digesting gram negative rods in butter or cream might well be used as an indication of the probable spoilage of butter (34). Small numbers of these proteolytic gram negative rods found in fresh lightly salted, sweet cream butter, held at temperatures which would permit the growth of these organisms, was invariably followed by large numbers of the organisms and a poor quality butter.

Although either tributyrin or milkfat agar might appear to be a more sensitive criterion in determining the spoilage of butter by micro-organisms, the toxicity of the tributyrin, the slight toxicity of the Nile blue sulfate, and the difficulties involved in the preparation and use of these media would probably preclude their general use.

The relation of these bacteria to the keeping qualities of various types of butters made and held under known and controlled conditions will be discussed in another paper.

SUMMARY

A study has been made of 486 cultures of bacteria isolated from butter made and held under known and controlled conditions. Only those organisms capable of hydrolyzing milkfat, or splitting tributyrin, or digesting casein have been included.

Of the cultures studied, 39 per cent (188) were gram negative rods; 31 per cent (151) were gram positive cocci; 15 per cent (74) were gram positive, aerobic, sporeproducing rods; 8 per cent (40) were gram negative micrococci; 5 per cent (23) were gram positive sarcina; and 2 per cent (10) were gram positive nonsporeproducing rods.

Those groups occurring in numbers large enough to be of probable significance in the spoilage of butter were gram negative rods, gram negative micrococci, gram positive sarcina, and gram positive nonsporeproducing rods.

In the butters supporting the growth of large numbers of bacteria, only the gram negative rods were regularly present in large enough numbers to be of importance in the spoilage of all of the butters tested.

New names have been suggested for five species of bacteria: *Micrococcus intermedius*, *Micrococcus lipolyticus*, *Micrococcus magnus*, *Micrococcus tributyrus*, and *Sarcina caseolytica*.

Data have been presented to show the importance of the use of milk agar as an indication of the keeping quality of butter.

A SUMMARY OF THE MORPHOLOGICAL AND PHYSIOLOGICAL PROPERTIES OF THE NEW SPECIES STUDIED

Micrococcus intermedius

Spheres: when old. Oval and rod-like when young. Occurring singly, in pairs and irregular masses. Gram positive.

Gelatin stab: No liquefaction.

Agar colonies: Large, moist, light-yellow colonies with dark centers; round, entire margin.

Agar slant: Light-yellow, moist, abundant growth with raised margin.

Broth: Turbid, yellow sediment.

Litmus milk: Alkaline; no curd, no proteolysis, no reduction.

Milkfat is hydrolyzed.

Tributylin is hydrolyzed.

Indol not formed.

Nitrates not reduced.

No acid in dextrose, lactose or sucrose.

Ammonia is produced.

Aerobic.

Grows generally at 10° C. and 37° C. Some may grow as low as 5° C. and some as high as 45° C. Does not grow at 50° C.

Micrococcus lipolyticus

Spheres: Occurring singly and in irregular clumps. Gram negative.

Gelatin stab: No liquefaction.

Agar colonies: Medium, white, moist, round; serrate margin.

Agar slant: White, thick, moist growth.

Broth: Turbid, white sediment.

Litmus milk: Alkaline; generally slight reduction; no curd, no proteolysis.

Milkfat is hydrolyzed.

Tributylin is hydrolyzed.

Indol not formed.

Nitrates not reduced.

No acid in dextrose, lactose, or sucrose.

Ammonia is produced.

Aerobic.

Grows at 5° C. and 37° C. and may grow at 40° C. Does not grow at 45° C.

Micrococcus magnus

Spheres: 2 to 3 microns in diameter. Occurring singly and in irregular clumps. Gram positive.

Gelatin stab: No liquefaction.

Agar colonies: White, moist, small to medium, irregular; depressed center with raised margin.

Agar slant: White, moist, rough, scanty growth.

Broth: Turbid, white sediment.

Litmus milk: Acid and slight reduction; generally curdled; no proteolysis.

Milkfat is hydrolyzed.

Tributylin is hydrolyzed.

Indol not formed.

Nitrates reduced to nitrites.

Acid from dextrose, lactose and sucrose.

Ammonia is produced.

Aerobic.

Grows at 10° C. and 45° C. Does not grow at 5° C. and 50° C.

Micrococcus tributyrus

Spheres: 1.5 to 2.5 microns in diameter. Occurring singly or in irregular clumps. Gram positive.

Gelatin stab: Liquefaction.

Agar colonies: Large, yellow, moist, round; thin irregular margin.

Agar slant: Light-yellow, thick, moist, raised.

Broth: Turbid, yellow sediment.

Litmus milk: Acid, curd, digestion, reduction.

Milkfat not hydrolyzed.

Tributylin is hydrolyzed.

Indol not formed.

Nitrates reduced to nitrites.

Acid from dextrose, lactose, and sucrose.

Ammonia is produced.

Aerobic.

Grows generally at 10° C. and 40° C., and may grow as high as 50° C. and as low as 5° C.

Sarcina caseolytica

Spheres: 1 to 1.5 microns in diameter, grouped in packets of eight. Gram positive.

Gelatin stab: Liquefaction.

Agar colonies: White, moist, medium to large; raised center, irregular margin.

Agar slants: White, moist, rough, scanty growth.

Broth: Slight turbidity, little sediment.

Litmus milk: Curd, digestion, reduction; no acid.

Milkfat not hydrolyzed.

Tributylin not hydrolyzed.

Indol not formed.

Nitrates reduced to nitrites.

Acid from sucrose; no acid in dextrose or lactose.

Ammonia is produced.

Aerobic.

Grows at 10° C. and 45° C. Does not grow at 5° C. and 50° C.

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THE FLUOROMETRIC ESTIMATION OF LACTOFLAVIN

G. C. SUPPLEE, S. ANSBACHER, G. E. FLANIGAN AND Z. M. HANFORD
Research Laboratories of the Dry Milk Company, Inc., Bainbridge, New York

Knowledge concerning the nature of the components of the vitamin B-complex has been extended by the comparatively recent studies of various authors. Many investigators (1-14) have called attention to the growth-promoting properties of pure lactoflavin, a yellow-red pigment which has been isolated from such products as whey (15, 16), egg (17, 18), liver (19, 20), yeast (21) and hay (22). Lactoflavin exhibits a marked greenish-yellow fluorescence, especially when subjected to the visible blue-violet rays (23). The fluorescent characteristics of impure lactoflavin concentrates, prepared from a water-soluble vitamin concentrate derived from milk, have been correlated with the growth-promoting properties of such concentrates (24). These studies as well as others of a similar character have indicated the possibility of utilizing the fluorescent properties of lactoflavin as a basis for the qualitative and quantitative estimation of this dietary factor. In order to determine the merits and limitations of such a procedure, pure lactoflavin must be used as the basis of study. Crystalline lactoflavin, isolated from the previously mentioned water-soluble vitamin concentrate derived from milk, has been employed for determining its fluorescent characteristics in the longer, invisible ultra-violet rays. The following experimental data, illustrated by photographic reproductions in true color of the "black light" fluorescence, indicate the value of the fluorometric method for the estimation of lactoflavin.

EXPERIMENTAL

Pure, crystalline lactoflavin was isolated from the crude milk vitamin concentrate (25) by a series of adsorption and elution procedures which resulted in impure concentrates of a relatively high lactoflavin content. Such concentrates were further purified by the formation of the insoluble silver salt and its decomposition with hydrogen sulfide which yielded a lactoflavin solution from which the pure substance was recovered by further adsorption and elution procedures followed by recrystallizations from alcohol. An amount of 1.2 gm. of pure lactoflavin was recovered from 32 kg. of the crude milk vitamin concentrate; such a recovery is several hundred times higher than the yields which other workers (15, 16, 21, 26, 27) obtained from liquid whey.

The crystalline character of the pure product is illustrated in the accompanying plates IB and I. In determining its melting-point it was observed that a change of state, indicative of melting and decomposition, took place

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within the temperature range of 267–294° C. Kuhn, Rudy and Weygand (28) have reported identical observations with crystalline lactoflavin and record a “melting point” of 293° C. (uncorr.)

The pure product, when dissolved in water shows a yellow fluorescence with a greenish cast in natural light if the concentration is sufficiently high. The fluorescence appears markedly intensified, when such solutions are examined in the longer invisible ultra-violet rays. This intensified fluorescence in “black light” seemed to indicate that it might be used as a basis of a method for the quantitative estimation of lactoflavin in solution. In view of its convenience and the character of its emissions an Eveready Fluoray lamp¹ was used in the development and application of the fluorometric method described hereinafter.

Preparation of Standard Lactoflavin Solutions: 25.473 mg (\pm 0.005 mg.) of the pure, crystalline lactoflavin were dissolved in a sufficient amount of water to obtain a stock solution which contained 250 γ /ml. of lactoflavin. Solutions of a known lactoflavin content were prepared by diluting appropriate samples of this stock solution with water; 5 ml. portions of these solutions were introduced into non-fluorescent glass vials, one drop of a 37 per cent formaldehyde solution added and the vials closed with cleaned stoppers. The range of concentrations prepared varied between 25.00 and 0.10 γ /ml. of lactoflavin. These standard solutions had a pH sufficiently close to the neutral point to assure the maximum fluorescence (29, 30).

Description of Light Source: The Eveready Fluoray lamp is a portable carbon arc lamp burning C carbon electrodes at 30 volts and 9 amperes (31) which emit a substantially continuous spectrum throughout the longer ultra-violet light range. The arc is entirely shielded except for a small opening which permits the passage of a small beam of light. The lamp is equipped with a molded, 4 mm. thick, heat-resisting red purple ultra filter No. 587.² This filter transmits only radiations between about 3100 and 4100 Å and very slightly in the extreme red (about 7200 Å); its peak transmission is at about 3650 Å.

Examination of the Lactoflavin Standards: Examination of the lactoflavin solutions in “black light” should be made in an appropriate room from which all light except that emitted by the lamp is entirely excluded. Preferably the examination should be made against a black, non-fluorescing and non-reflecting background. Under such conditions the standard solutions exhibit a brilliant yellow fluorescence with a greenish cast, as reproduced in the accompanying plates II and III. The quality of the fluorescence appears to be the same in all the standard solutions, but, in the accompanying plates, the standard solutions of lower concentrations seemed to have an

¹ The Eveready Fluoray lamp was obtained through the courtesy of The National Carbon Company, Cleveland, Ohio.

² This filter is manufactured by the Corning Glass Works, Corning, New York.

increased greenish cast; this is probably due to the fact that the standard solutions were photographed against a black background. The intensity of the fluorescence, however, decreases with decreasing lactoflavin concentrations within the 25–0.1 γ /ml. range and it seems that the rate of decreasing intensity increases with decreasing concentrations. The relative fluorescence intensity of a 50 γ /ml. and a 25 γ /ml. solution appeared not to be sufficiently different to be used for analytical purposes. The lower range of concentrations, as e.g. 2.5–0.1 γ /ml. of lactoflavin, however, did show contrasting differences in fluorescence intensity suitable for a fluorometric comparison. The extinction point was found to be a concentration of about 0.05 γ /ml. of lactoflavin.

Parenthetically it should be noted that examination of the standard solutions in the light of the unscreened arc showed that solutions containing less than 1 γ /ml. of lactoflavin do not exhibit a fluorescence detectable with the naked eye. However, von Euler and Adler (32) were able to examine solutions containing as little as 0.02 γ /ml. of lactoflavin in the condensed light of an unscreened carbon arc. When observed in natural light, the solutions of higher concentrations appear to be yellow and those of lower concentrations practically colorless.

Estimation of Pure Lactoflavin in Solutions of Unknown Concentrations: Lactoflavin solutions of unknown concentrations were compared in "black light" with the standard solutions for the purpose of ascertaining the reliability and limitations of the method. Fractions of such unknown solutions, which upon preliminary examination in "black light" were estimated to contain in excess of 25 γ /ml. of lactoflavin, were diluted with water to make a series of concentrations which showed a fluorescence intensity comparable to standard solutions containing less than 2.5 γ /ml. After calculating the concentration of lactoflavin by reference to the standard solutions and then referring to the concentration of the original sample, known to other individuals but withheld from the analyst until after the determination by the fluorometric method had been completed, it was found that a degree of accuracy within 0.1 γ of lactoflavin could be obtained readily.

Estimations of Lactoflavin in Impure Concentrates: The above method of estimation is not only applicable to solutions of pure lactoflavin but also to lactoflavin concentrates containing a relatively high amount of impurities, provided that the fluorescent color is not interfered with by the impurities. This interference may frequently be overcome by proper dilution. The method was applied, for example, to a lactoflavin containing elution product obtained by treating a fullers' earth adsorbate with dilute pyridine [Sample 2-550 (24)]. This sample contained 33,500 γ of total solids per ml., much of which was extraneous matter other than lactoflavin. The sample was diluted to different concentrations varying from 33.55 γ /ml. to 5.03 γ /ml. of total solids. These dilutions which appeared practically colorless in day-

light were examined in "black light" in comparison with the standard solutions. It was found that the fluorescence intensity of the 26.84 γ /ml. concentration matched with that of the 0.50 γ /ml. standard lactoflavin solution; the fluorescence intensity of the 13.42 γ /ml. concentration matched with that of the 0.25 γ /ml. of standard lactoflavin solution; the fluorescence intensity of the 0.10 γ /ml. standard lactoflavin solution was slightly lower than that of the 6.71 γ /ml. concentration and slightly higher than that of the 5.03 γ /ml. concentration. From these data it was calculated that the unknown sample (2-550) contained 620.68 γ of lactoflavin per ml. or per 33,500 γ of total solids.

The above example clearly shows the applicability of the method particularly when the examination of the unknown sample is made in comparison with pure lactoflavin solutions within the 0.5-0.1 γ , ml. range.

DISCUSSION

The above data as a whole seem to show that the fluorometric method is accurate and can be applied to pure lactoflavin solutions and to lactoflavin concentrates containing relatively high amounts of impurities. The method was found to be very useful in the process of isolation of lactoflavin from various sources; it permits e.g. ascertaining the efficiency of adsorbents and eluting agents employed in the quantitative recovery and purification of lactoflavin.

The method was found to be applicable also for obtaining relative approximations of the lactoflavin content of such biological materials as e.g. dried liver, spinach, milk, whey, crude milk sugar, etc. The applicability of the method for estimating the lactoflavin content of such material depends upon the completeness with which the lactoflavin can be extracted by various solvents; acetone in proper dilutions has been found to be very convenient when applied to certain biological materials.

Various data which will be reported in subsequent papers seem to show conclusively that comparable and consistent results can be obtained by the fluorometric method described. The results obtained with the fluorometric method were correlated with the biological data concerning the growth-promoting properties of lactoflavin which now appear to serve as further confirmatory evidence substantiating the merits of the fluorometric method as an adjunct facilitating biological investigations involving this dietary factor.

SUMMARY

Pure, crystalline lactoflavin has been prepared from a water-soluble vitamin concentrate derived from milk. A method of estimating lactoflavin involving its fluorescent properties in "black light" is presented. The method is simple, involving only standard lactoflavin solutions and an ultra-

violet light generator equipped with a suitable filter. The method was found to be accurate to 0.1 γ of lactoflavin, but concentrations as low as 0.05 γ /ml. of lactoflavin could be detected.

The authors acknowledge the cooperation of the Phototechnical Department of the Agfa Ansco Corporation, Binghamton, New York; The National Carbon Company, Cleveland, Ohio and The Caxton Company, Cleveland, Ohio. The assistance of Dr B. L. Herrington, temporarily employed by The Dry Milk Research Laboratories, is also gratefully acknowledged.

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PLATE IB
Crystalline Lactoflavin from Milk Vitamin Concentrate.
(Magnification X 60)

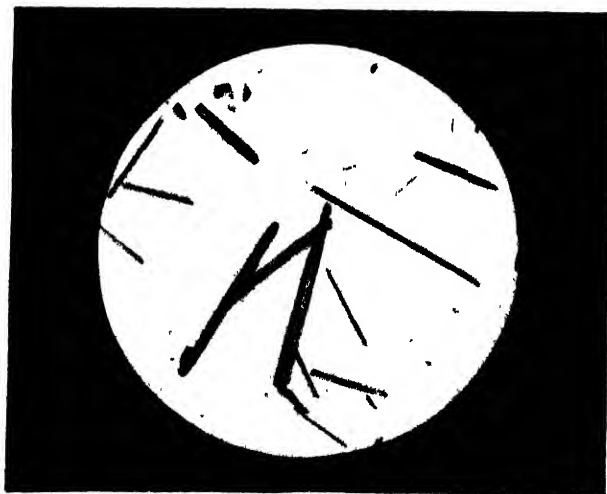


PLATE I.
Crystalline Lactoflavin (natural color) from Milk Vitamin Concentrate.
(Magnification X 60)

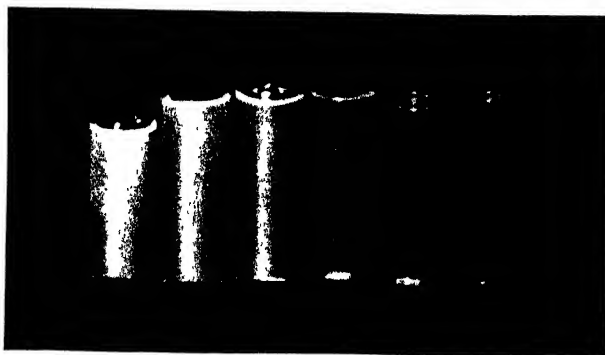


PLATE II

Fluorescent Color of Pure Lactoflavin in "Black Light".

Tube 1	25	gamma per cc
Tube 2	15	gamma per cc
Tube 3	10	gamma per cc
Tube 4	5	gamma per cc
Tube 5	2.5	gamma per cc
Tube 6	Distilled Water.	

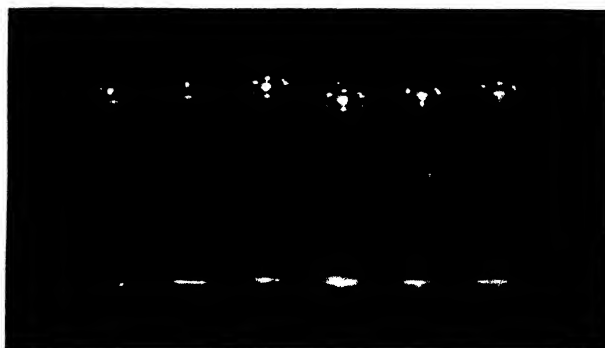


PLATE III.

Fluorescent Color of Pure Lactoflavin in "Black Light".

Tube 1	1.50	gamma per cc.
Tube 2	1.00	gamma per cc
Tube 3	0.50	gamma per cc
Tube 4	0.25	gamma per cc.
Tube 5	0.10	gamma per cc.
Tube 6	Distilled Water.	

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OBSERVATIONS ON THE FREEZING OF MILK AND CREAM II. THE DESTRUCTION OF THE FAT EMULSION IN FROZEN CREAM*

F. J. DOAN AND F. BRUCE BALDWIN, JR.

Pennsylvania Agricultural Experiment Station, State College, Pa.

Cream which has been partially frozen or frozen to apparent solidity for the purpose of storage, almost invariably shows evidence, upon thawing, of a partial destruction of the fat emulsion. This phenomenon has been noted and studied by several investigators (1, 2, 3, 4). Recently Webb and Hall (5) have shown this separation of "free fat" to increase with the fat content of the cream and suggest that it is dependent on several factors, the most important being, "the freezing point of the aqueous phase, the protection afforded the emulsified fat by adsorbed protein, and the size of the fat globules themselves." Sommer (6) attributes the breakdown of the fat emulsion to the destabilization of the protein adsorption film, around the fat globules, brought about by freezing. However, it has been shown that the protein of frozen milk and cream is not appreciably affected until after a considerable interval of holding in the frozen condition (1, 5) whereas the fat emulsion is immediately affected (1, 3, 5). Mack (7), Price (8), and also Webb and Hall have found that additions of sugar to cream before freezing markedly decrease the amount of oiling off of the fat after thawing.

EXPERIMENTAL

Methods

To study the effect of freezing upon the destruction, of the fat emulsion, samples of commercially pasteurized cream containing 25 and 40 per cent fat and 40 per cent of fat plus 10 per cent of sucrose, respectively, were frozen in two-quart tin containers, without agitation, in still air, at -23° to -28° C. until congealed to varying degrees. Approximately 9-10

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hours were required to freeze to apparent solidity under these conditions. After freezing the samples were thawed in a water bath held at 10° C. They were not stirred until all the ice was melted and then the sample was poured through a 30-mesh screen. The material on the screen was weighed and analyzed for fat by a modified Babcock method. The amount of fat thrown out of emulsion by freezing was calculated as the per cent of the total fat in the sample.

Samples were taken from the freezing room when the amount of freezing (determined as explained in the previous paper (9) varied from 10 per cent to apparent solidity.

To study the internal pressure developed in the samples of cream during freezing, a manometer arrangement was set up. This consisted of a rubber bulb which was placed in the sample at the point which previous experiment had indicated to congeal last. The bulb was filled with alcohol and was connected to the U tube of the manometer by glass tubing. The tubing was filled with alcohol from the bulb to the top of the mercury column of the U tube. The relative pressure developed in the samples was read in millimeters, being the difference in level of the mercury in the two sections of the U tube.

The Effect of the Degree of Freezing on the Fat Emulsion

Samples of 25 per cent cream, 40 per cent cream and 40 per cent cream containing 10 per cent of sucrose were frozen to various degrees and the

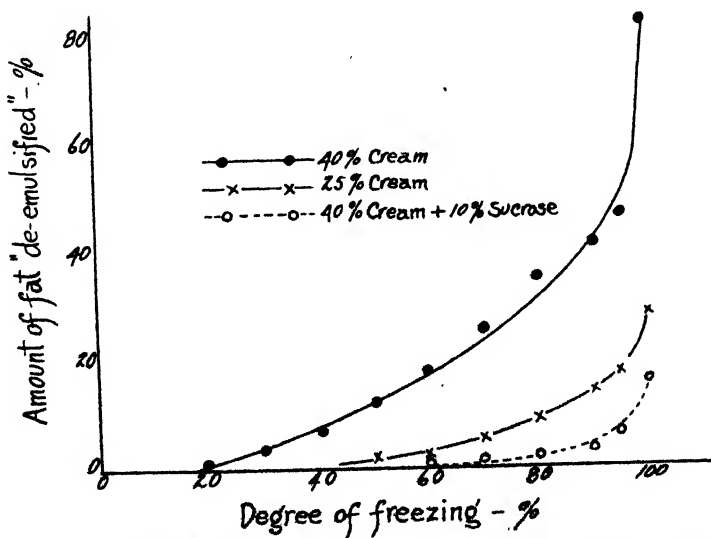


FIG. 1. The effect of the degree of freezing upon the amount of fat thrown out of emulsion in cream.

amount of fat thrown out of emulsion determined. It was found that the amount (expressed as percentage of the total fat) increased with the degree of freezing and with the fat content of the cream. It was also noted that the fat of the cream containing sucrose was less affected than where sucrose was not present. The average data obtained from six to eight trials with each product are presented in Figure 1. Apparently the fat emulsion was not affected appreciably until freezing had progressed to the point where 50 per cent of the 40 per cent cream was congealed, 80 per cent of the 25 per cent cream was frozen and until the 40 per cent cream containing sugar was practically frozen solid. In all three products, however, the effect of freezing was most marked when the point of solidity was approached or attained. When the creams were frozen to apparent solidity, the 40 per cent cream had, on the average, over 80 per cent of the fat thrown out of emulsion, the 25 per cent cream, about 30 per cent, and the 40 per cent cream containing sucrose, about 15 per cent. The figure for 40 per cent cream was somewhat higher than that reported by Webb and



PLATE 1. Cross section of frozen 40 per cent cream.

Hall (5), the difference probably being due to the difference in the method employed for measuring the free fat.

Pressure Developed in Freezing Cream

In the previously reported studies on freezing of skim milk, whole milk and cream (9), it was noticed that the surface of the samples congealed rather early. As more ice was formed it appeared that the surface layer tended to restrict further expansion causing a pressure which usually bulged the surface in the later stages. Plate 1 shows a photographic view of a cross section of one of the two-quart samples of 40 per cent cream frozen to approximately 90 per cent. It is not difficult to visualize how and why pressure would develop in this freezing mass, when it is considered that the surface freezes over at the very beginning of the freezing process. Using the manometer described, pressure was quite evident and it could be followed during the course of freezing. Average data obtained in six trials with the three types of cream are shown in Figure 2.

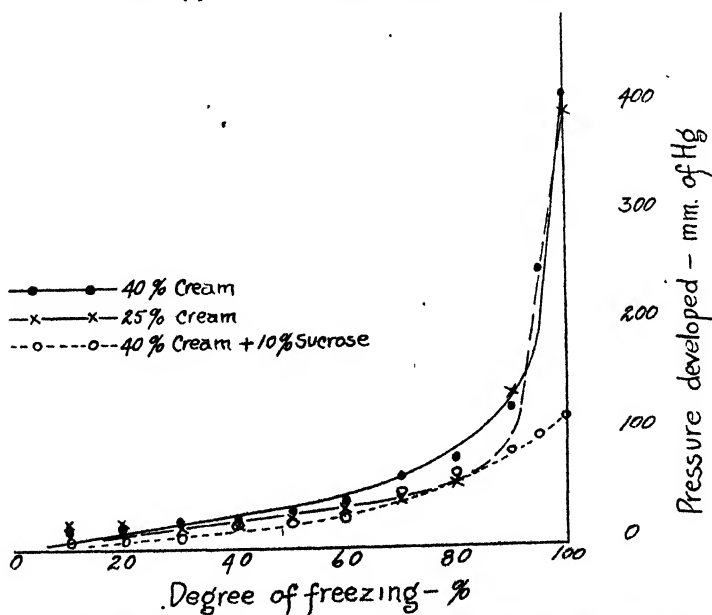


FIG. 2. The effect of the degree of freezing upon the amount of pressure developed in cream.

In the first stages of freezing the pressure increased very slowly. The rate of increase became more rapid, with cream containing no sugar, when freezing had progressed to 60-70 per cent, and increased precipitously between 90 per cent and the apparently solid state. The pressure develop-

ment in 40 per cent cream containing sucrose followed unsweetened cream to the point where the product was about 80 per cent frozen but no great increase in pressure occurred between this point and the state of apparent solidity such as was found in the case of unsweetened cream. The maximum pressure developed in sweetened cream was roughly only one-fourth as great as in unsweetened cream.

Maximum pressure developed in the freezing of all three samples of cream at a point coincident with the point of apparent solidity. Further holding under freezing conditions witnessed a gradual drop in pressure. This is not shown in the figure but is interpreted as indicating a gradual slipping of the congealed surface along the sides of the container and frequently a more pronounced bulging of the surface. Both of these occurrences could be noted by measure but not very accurately.

Further holding under freezing conditions did not materially effect the amount of fat "de-emulsified" in the cream. Because of this fact and the similarity of the curves shown in Figure 1 and Figure 2, it is thought that the pressure developed in cream frozen without agitation is an important

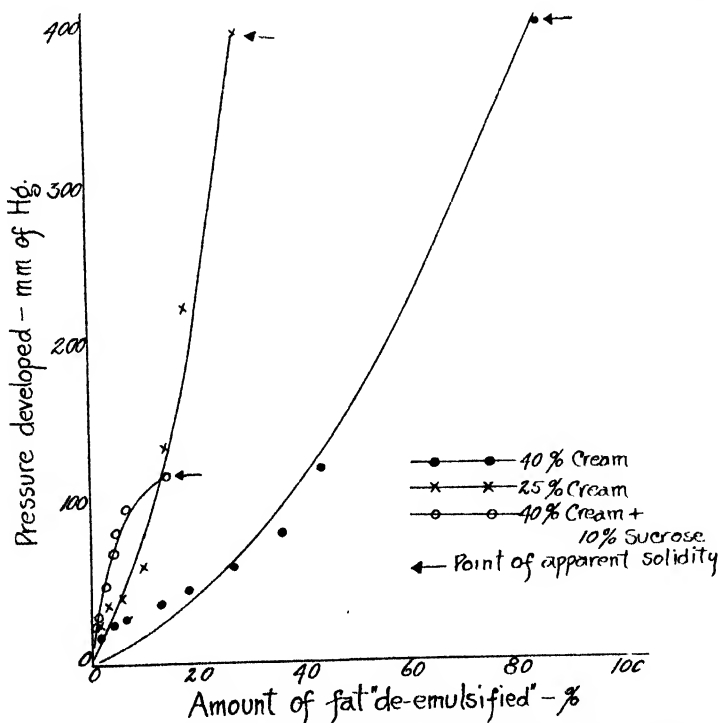


FIG. 3. The relationship between the amount of fat thrown out of emulsion and the pressure developed in freezing cream.

factor (perhaps the most important) in explaining the destruction of the fat emulsion.

Relation Between Pressure and "De-emulsified" Fat

If the data shown in Figures 1 and 2 are plotted to show the relationship between pressure and the per cent of fat "de-emulsified," the curves presented in Figure 3 are obtained. This figure indicates a close relationship between pressure developed during freezing and the amount of fat thrown out of emulsion. The curves are nearly straight lines showing that the per cent of fat "de-emulsified" in the freezing of cream is almost a linear function of the pressure developed. The difference in the amount of fat affected in 25 per cent cream as compared with 40 per cent cream is undoubtedly due to the difference in fat concentration. The difference, in this respect, between unsweetened and sweetened 40 per cent cream is not so easily explained. The low pressure developed in sweetened cream at the point of apparent solidity can be attributed to the smaller ice crystals formed when sugar is present since the small crystals do not build up into a surface structure capable of holding its place against expansion nearly so effectively as does the larger, harder ice structure formed over the surface of unsweetened cream. Furthermore, at a given temperature less water would be frozen in sweetened cream due to the considerably lowered freezing point. This lower maximum pressure is reflected in a much smaller amount of fat thrown out of emulsion. But the amount is still only about one-third as great as occurs in unsweetened 40 per cent cream at a like pressure. The sucrose present must exercise some influence other than that of minimizing the pressure developed, which tends to protect the fat against coalescence.

Similarity Between Freezing and Churning in Destroying the Fat Emulsion of Cream

When frozen and thawed 25 per cent and 40 per cent cream were compared with similar samples churned at 50° F. until approximately the same amount of fat was thrown out of emulsion, it was impossible to distinguish between them in appearance. Under the microscope the fat aggregates were identical, as far as could be judged.

When cream was churned (a small Daisy Churn was used), samples removed periodically during the process showed an increasing pH up to the "breaking point" for the butter followed by a drop to approximately the original value, when the determination was made electrometrically using the quinhydrone electrode. It is believed that this change is more apparent than real, possibly due to an interference with electrical conductivity on the part of the myriads of minute butter particles in the first stages of aggregation. Palmer (10) has shown that electrical conductivity is at a minimum just previous to the "breaking point" of the butter when cream is churned.

This phenomenon of increasing pH as cream is churned probably explains the difficulty encountered by Sharp and McInerney (11) in obtaining the correct values for the pH of cream using the Bailey electrode.

Similar results were obtained when samples of cream were frozen to increasing degrees, thawed and the pH determined. The readings increased with the degree of freezing but since the "breaking-point" for butter was seldom reached (not more than 80-85 per cent of the fat being thrown out of emulsion, even with solid freezing of 40 per cent cream), the increase was not so great and the drop to the original figure did not occur. Comparative data for 40 per cent cream, churned and frozen, are shown in Table 1.

TABLE 1
The pH of 40 per cent cream during churning and during freezing

n of sample		pH	
		Trial 1	Trial 2
Not churned		6.56	6.60
Viscous stage		6.61	6.66
No sign of butte granules		6.66	6.70
Slightly flaking		6.70	
Very small but able granules		6.81	6.80
Buttermilk		6.54	6.55

FREEZING			
Proportion frozen	Proportion fat De-emulsified	Trial 1	Trial 2
%	%		
Not frozen	0	6.53	6.56
20-30	2-5	6.54	6.58
80-90	30-40	6.62	6.63
90-100*	40-60	6.60	6.65
Held solid 4 hrs.	80-85	6.65	6.68

* Apparently solidity.

Whatever is responsible for this effect on the pH values, it is common to cream churning and cream freezing and is interpreted as indicating that the process of fat "de-emulsification" is essentially the same whether the cream emulsion is destroyed by agitation or by the pressure of freezing.

Actually pressure may be an important factor in the destruction of the fat emulsion of milk or cream by whatever means accomplished. In the churning of cream, the tremendous concussion and agitation undoubtedly cause localized, intermittent zones of pressure and the rapidly moving layers of cream, very likely, cause pressure of fat globule on fat globule, gradually wearing away or rupturing the layer of adsorbed protective covering and allowing the free fat to coalesce or adhere to other free fat in such a manner

that butter aggregates are gradually built up in which the individual globules eventually lose their identity.

Pressure and agitation caused by the homogenizer appear to act in similar fashion when cold cream is processed and cold plastic cream containing 70 to 85 per cent of fat, largely in the emulsified state, can be transformed into butter by a suitable application of pressure.

Effect of Freezing on Protein Stability

It seems unnecessary to present further data relative to the effect of freezing on the stability of the protein phase of milk or cream in view of the work already reported, particularly that of Webb and Hall (5). Freezing, *per se*, has no measurable effect on the protein dispersion. Holding in the frozen condition for several weeks or months is required to definitely cause aggregation, denaturization or instability of the proteins.

Inasmuch as it is believed by some that the destruction of the fat emulsion in the freezing of milk and cream is due to the destabilization of the protein agents of emulsion which help to protect the fact, efforts were made to increase the protein stability and lessen or prevent such "de-emulsification." The methods used included the addition of small amounts of sodium citrate and sodium carbonate added to the cream before freezing, and the addition of skimmilk previously heated to 82° C. and cooled. None of these treatments made any noticeable difference in the amount of fat thrown out of emulsion. The conclusion to be drawn, therefore, is that changes in the stability of the protein phase play a very minor rôle in either aiding or preventing "de-emulsification" of the fat when cream is frozen.

CONCLUSIONS.

When cream is frozen in containers without agitation, pressure is developed due to the fact that the surface freezes over early and subsequent conversion of water into ice, in the unfrozen center, causes expansion which is partially restricted by the ice structure of the surface.

For cream of uniform fat content, the percentage of fat thrown out of emulsion by freezing is roughly proportional to the pressure developed.

Additions of sugar to cream limit the amount of pressure developed in freezing due to the smaller size of ice crystals which form a less rigid frozen surface and also to the fact that at given temperatures less water freezes. Less fat is "de-emulsified" in sweetened frozen cream than in unsweetened cream and less than in unsweetened cream frozen to the same pressure.

The fat aggregates developed in freezing cream seem to be identical with the fat aggregates caused by agitation such as churning and the mode of formation appears similar.

It is concluded that in the destruction of the fat emulsion brought about by the unagitated freezing of cream, the pressure developed by the con-

gealing water is the causative factor of most importance. The freezing point of the aqueous phase is a factor primarily through its effect on the pressure and the stability of the protein as an emulsifying or protective colloid is not an important factor within the limits of its variability under commercial conditions.

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SOME FACTORS INFLUENCING THE ACIDITY OF FRESHLY DRAWN COWS' MILK¹

W. J. CAULFIELD AND W. H. RIDDELL

Kansas Agricultural Experiment Station

INTRODUCTION

In the course of another investigation dealing with normal variations in the curd tension of milk a large number of acidity determinations were made on the fresh milk from individual cows. The results indicated higher average acidity values than have generally been reported in the literature. In several textbooks the acidity of fresh milk has been reported as ranging from 0.10 to 0.14 per cent. Preliminary studies at this station indicated that such low values are not typical of any large number of cows. This observation led to the organization of a project in 1933 for a detailed study of the titratable acidity of fresh milk from individual cows in the Kansas Agricultural Experiment Station dairy herd over an extended period of time.

Factors studied as possibly connected with the acidity of cow's milk were: 1, breed; 2, individuality of the cow; 3, stage of lactation; 4, variations from month to month; 5, variations from day to day, and 6, variations from milking to milking. The acidity of the milk from each cow was determined monthly over a fourteen month period. More frequent determinations were made with selected groups of cows for shorter periods of time in conducting certain phases of the investigation.

PROCEDURE

The technique used by different investigators in determining the titratable acidity of milk has varied widely. This fact undoubtedly is an important factor in the variable results which have appeared in the literature. Sommer and Menos (1) have shown that the addition of an equal volume of water to a sample of milk lowers its titratable acidity approximately 0.02 per cent, and the addition of nine volumes of water lowers it 0.06 per cent. Burgwald and Bachtel (2) found that an increase in the amount or concentration of indicator lowered the results of an acidity determination. This observation has been verified by the authors. When replicate 18-gram samples of whole milk were titrated with varying amounts (3 drops to 2.0 cc.) of a 1 per cent solution of phenolphthalein indicator, the following results were obtained: 3 drops of indicator, 0.172 per cent acid; 0.5 cc.,

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0.159 per cent acid; 1.0 cc., 0.154 per cent acid; 1.5 cc., 0.151 per cent acid; and with 2.0 cc. of indicator, 0.149 per cent acid.

These results represent average values obtained by three individuals working independently. In each case eight replicate titrations were made with each quantity of indicator.

The size of milk sample is another variable factor which will affect the results. If a 9 cc. pipette is used, the actual weight of the sample will be approximately 9.27 grams. On the other hand, if a 17.6 cc. pipette is used, the sample will weigh 18 grams. In the calculation of the results the weights of the sample would be considered 9 and 18 grams respectively. Higher results would therefore be expected if a 9 cc. pipette were used as compared to a 17.6 cc. pipette.

It is evident that a carefully standardized procedure for determining the titratable acidity of whole milk must be employed if comparable results are to be obtained. The following procedure was used in the present experiment: A 17.6 cc. (approximately 18 grams) sample of milk was measured into a white cup by means of a whole milk pipette. Four drops of a 1 per cent solution of phenolphthalein indicator were added to the sample. Tenth normal sodium hydroxide was slowly added to the sample from a burette until a faint pink color was observed. The results are expressed as lactic acid in all cases.

In the determination of acidity at monthly intervals a sample of milk from the entire milk of each cow was obtained at the time of the evening milking. The samples were placed immediately in ice water and the acidity determined within 15 minutes.

When it was necessary to obtain samples from both milkings, the same procedure was followed except that the samples collected at the morning milking were held in ice water for a period not to exceed 5 hours before the acidity determination was made.

In studying the influence of lactation on acidity, milk samples were obtained from a group of 10 cows for the first six successive milkings following parturition and at less frequent intervals thereafter over a period of one month. Hydrogen ion determinations were also made by means of the quinhydrone electrode against a saturated calomel electrode at 25° C.

RESULTS

Variations due to breed of cows: The average acidity of the milk for the different breeds varied as follows: Ayrshire, 0.160 per cent; Holstein, 0.161 per cent; Guernsey, 0.172 per cent; and Jersey, 0.179 per cent (Table 1). The acidity of the milk from the Holstein and Ayrshire breeds showed no significant differences. Similarly there was no significant differences in the average acidity of the milk from the Jersey and Guernsey breeds. There is, however, a difference in the acidity of the milk from the higher testing

TABLE 1
Influence of breed on the titratable acidity of fresh milk

BREED	SAMPLES	AVERAGE ACIDITY	COEFFICIENT OF VARIATION
	(No)	(%)	(%)
Ayrshire	229	0.160 \pm .005	4.5
Holstein	297	0.161 \pm .004	4.0
Guernsey	153	0.172 \pm .005	4.7
Jersey	132	0.179 \pm .006	4.3
All breeds	811	0.166 \pm .005	4.2

breeds (Jersey and Guernsey) as compared with the Holstein and Ayrshire breeds. The milk from the Channel Island breeds averaged from 0.011 to 0.019 per cent higher than did the milk from the other breeds.

Coefficients of variation ranging from 4.0 per cent for the Holstein breed to 4.7 per cent for the Guernsey breed show that the data were grouped quite closely around the mean values for each of the different breeds.

Variations due to individuality of the cow: While it has been pointed out that the acidity of fresh milk from individual cows varies widely, little data have been presented to indicate the frequency of such variations. The acidity of the milk from individual cows in the present study (exclusive of samples obtained at the very beginning or end of the lactation period) varied from 0.098 to 0.295 per cent. These values are in general agreement with Henkel (4) who examined 10,000 or more samples of individual cow's milk and found them to vary from 0.1237 to 0.2025 per cent. McInerney (5) reported acidity values ranging from 0.10 to 0.22 based upon the ex-

TABLE 2
*Distribution of 811 acidity determinations on freshly drawn milk from individual cows**

INTERVAL PER CENT	PER CENT OF DETERMINATIONS FALLING WITHIN THE INTERVAL INDICATED				
	Ayrshire	Holstein	Guernsey	Jersey	All breeds
0.08-0.0999	0.4	0.0	0.0	0.0	0.1
0.10-0.1199	3.9	1.0	0.0	0.8	1.6
0.12-0.1399	15.7	15.8	9.8	7.6	13.3
0.14-0.1599	25.3	29.3	20.3	7.6	23.0
0.16-0.1799	37.1	35.4	32.0	29.6	34.4
0.18-0.1999	12.6	15.2	28.1	32.6	19.7
0.20-0.2199	4.4	2.0	7.2	19.7	6.5
0.22-0.2399	0.4	0.7	1.3	2.3	1.0
0.24-0.2599	0.0	0.0	0.7	0.0	0.1
0.26-0.2799	0.0	0.7	0.0	0.0	0.1
0.28-0.2999	0.0	0.0	0.7	0.0	0.1
	99.8	100.1	100.1	100.2	99.9

* The samples by breeds were distributed as follows: Ayrshire 229, Holstein 297, Guernsey 153, Jersey 132.

amination of the milk from 42 cows. Somner and Hart (6) found the acidity of 86 tests on individual samples from 31 cows to range from 0.102 to 0.257 per cent.

When the results on 811 milk samples were grouped in a frequency distribution table according to the percentage of acid present it was found that approximately 80 per cent of the samples for the different breeds fell within the following intervals: Holstein and Ayrshire, 0.12 to 0.18 per cent; Guernsey, 0.14 to 0.20 per cent; and Jersey, 0.16 to 0.22 per cent.

For all breeds, 1.7 per cent of the samples analyzed fell below 0.12 per cent acid and only 7.8 per cent of the samples were over 0.20 per cent acid. These data indicate that while the acidity of milk from individual cows varies widely, the percentage of samples falling near either extreme is limited.

Variations due to the lactation period: Colostrum milk from 10 cows was found to be high in acidity (Table 3). Milk samples from this group

TABLE 3
Acidity and pH values of milk samples from ten cows following parturition

	NUMBER OF MILKINGS AFTER PARTURITION					
	1	2	3	4	5	
Number of cows	10	10	10	10	10	10
Average acidity (%)	0.44	0.34	0.26	0.24	0.24	0.21
Coeff. of variation (%)	16.0	17.0	13.0	19.0	6.0	11.0
Average pH values	6.25	6.33	6.35	6.38	6.36	6.46
Coeff. of variation (%)	5.0	5.0	4.0	5.0	4.0	3.0

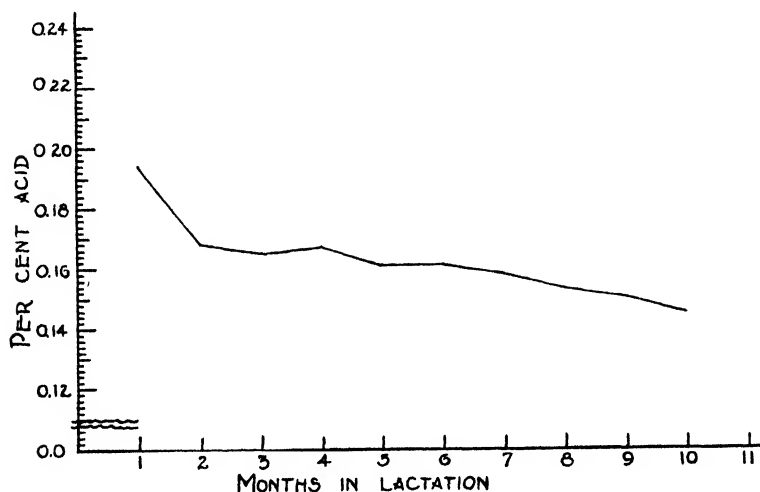
	DAYS AFTER PARTURITION					
	5	10	15	20	25	30
Number of cows	10	10	10	10	10	10
Average acidity (%)	0.20	0.19	0.17	0.16	0.16	0.16
Coeff. of variation (%)	7.0	6.0	5.0	8.0	11.0	12.0
Average pH values	6.47	6.54	6.57	6.58	6.58	6.58
Coeff. of variation (%)	6.0	6.0	3.0	6.0	3.0	2.0

averaged 0.44 per cent acid for the 1st milking, 0.34 per cent for the 2nd milking, 0.26 per cent for the 3rd milking, and at the 6th milking the acidity was 0.21 per cent (Table 3). The pH values were in harmony with the trend in titratable acidity (Table 3).

While the acidity of the milk continued to decline for a period of 15 to 20 days following parturition, the change was most apparent in the first three milkings (Table 3). On the fifth day the average acidity of the milk was 0.20 per cent, on the tenth day 0.16 per cent. No change in either the titratable acidity or pH was observed from the 20th to 30th days respectively.

Coefficients of variation ranging from 6 to 17 per cent for the first six milkings following parturition reflect the variability in acidity for individual cows. All cows within the group, however, showed the same general trend, namely, a high initial acidity followed by a progressive decline during the early part of the lactation period.

Observations made at monthly intervals on a group of 36 cows (12 Ayrshires, 11 Holsteins, 7 Guernseys, and 6 Jerseys) for a complete lactation showed that the acidity of the milk has a tendency to decline throughout the entire lactation (Figure 1). The most significant drop, however, oc-



curred between the first and second months of the lactation. The average acidity of the milk for the first month of the lactation was 0.194 per cent and by the second month it had declined to 0.168 per cent, a difference of 0.026 per cent. From the second through the seventh month of the lactation the average acidity of the milk remained quite constant. Following this a small decline was registered from 0.158 per cent for the seventh month to 0.145 per cent for the tenth month respectively. These data substantiate the findings of Houston (7) who observed a similar trend in the acidity of milk from a group of cross-bred Shorthorn cows.

The stage of lactation has a significant influence on the variability in acidity of milk from an individual cow. It was observed that all cows whose milk showed an acidity of 0.22 per cent or over had been fresh for 15 days or less at the time the determinations were made (Table 2), while extremely low values were usually associated with cows near the end of their lactations.

Although there is a general tendency for the acidity of milk to decline as the lactation advances, individual cows will show considerable variation

in this respect. Data obtained on a group of 8 cows in advanced stages of lactation showed that the average acidity of the milk had declined from 0.14 per cent, approximately one month prior to the end of the lactation, to 0.08 per cent on the last day of the lactation. However, the milk from some of the cows in this group showed very little change, whereas, in other instances a pronounced decline occurred. If a cow is showing good average milk production near the end of a normal lactation period, the decline in acidity does not appear to be so pronounced as when milk production is low. Data taken from two groups of cows during the last month of lactation substantiate this statement. One group of cows with an average daily milk production of 5.8 pounds showed an average acidity of 0.132 per cent, whereas, with a second group of 8 cows producing 15.8 pounds daily, the acidity of the milk averaged 0.169 per cent.

Variations in acidity from month to month: The average acidity of the milk from each of the four breeds showed some variation from one month to the next over a fourteen months' period. The monthly average acidity of the milk from the different breeds varied as follows: Holstein, 0.155 to 0.179 per cent; Ayrshire, 0.148 to 0.166 per cent; Guernsey, 0.172 to 0.189 per cent; and Jersey 0.172 to 0.189 per cent respectively.

Variations in the average monthly acidity for each of the breeds can be attributed primarily to differences in the stage of lactation and to the number and individuality of the cows represented in any one month. Several cows in any one breed freshening in a particular month will result in an increase in the average acidity for that month. Likewise, if several cows in any one breed are in advanced stage of lactation, the average acidity for the month generally will be lower. No seasonal trend was observed in connection with the monthly average acidity of the milk for the different breeds.

Variations from day to day and from milking to milking: Variations in the acidity of the milk for a group of 6 cows were observed over a 10-day period. Acidity determinations were made on samples collected from consecutive milkings for a period of 10 days.

Daily averages for the acidity of the milk from this group of cows did not vary more than 0.012 per cent throughout the 10-day period. It was true also that the differences in the acidity of the morning and evening milk were not significant. On the other hand, the acidity of the milk from individual cows did show some variation. The maximum variation observed between any two consecutive milkings was 0.038 per cent.

SUMMARY AND CONCLUSIONS

The titratable acidity of the freshly drawn milk from all cows in the college dairy herd was determined at monthly intervals over a period of 14

months. More frequent determinations were made with selected groups of cows for shorter periods of time. A total of 811 milk samples were examined (approximately 60 cows) distributed as follows: Holstein, 297; Ayrshire, 229; Guernsey, 153; Jersey, 132. Factors studied were: 1, breed; 2, individuality of the cow; 3, stage of lactation; 4, variations from month to month; 5, variations from day to day; and 6, variations from milking to milking. The following is a summary of the results:

1. The acidity of the milk for the different breeds averaged as follows: Ayrshire, 0.160 per cent; Holstein, 0.161 per cent; Guernsey, 0.172 per cent; and Jersey 0.179 per cent. The milk from all breeds averaged 0.166 per cent acid.

2. The acidity of the milk from individual cows studied varied from 0.098 per cent to 0.295 per cent respectively. Approximately 80 per cent of the samples for any one breed could be grouped within an interval range of 0.06 per cent acid. The limits of the interval, however, must be adjusted for the different breeds.

3. The acidity of colostrum milk was found to be high, averaging 0.44 per cent for the first milking for a group of 10 cows. With each succeeding milking a decrease occurred so that by the third milking the acidity of the milk averaged 0.26 per cent and at the sixth milking the acidity was 0.21 per cent. A gradual decline in acidity occurred during the first 15 to 20 days of the lactation.

4. The acidity of the milk from a group of 36 cows showed a gradual decline throughout the lactation. The most pronounced changes occurred near the beginning and end of the lactation period. From the second through the seventh month of the lactation the acidity remained fairly constant.

5. A marked decline in the average acidity of milk was observed during the last month of the lactation period. The extent of the change, however, varied widely between individual cows.

6. Variations from month to month in the acidity of milk for the different breeds were not large. Differences in the stage of lactation and in the number and individuality of the cows represented in any one month appear to be responsible for the variations in the monthly breed averages for acidity which were found to occur.

7. Average variation in the acidity of milk from day to day and from milking to milking for a group of 6 cows over a 10-day period were not significant. The milk from individual cows within the group did show some variation from one milking to the next. The maximum variation between any two consecutive milkings was 0.038 per cent.

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INTRA-MAMMARY DUCT INJECTIONS IN THE STUDY OF LACTOSE FORMATION*

W. R. BROWN,¹ W. E. PETERSEN² AND R. A. GORTNER¹
College of Agriculture, St. Paul, Minnesota

As intravenous injections of sugars did not prove satisfactory in the production of a hyperglucemic condition, it was decided to study the effect of introducing sugars into the mammary gland upon the blood sugar level. Several literature references supported probable success of the idea. Jackson and Rothera (5) were the first to report a decrease in lactose content of milk if the removed milk was reintroduced into the udder. Davidson (2), studying the effect of incomplete removal of milk, found a subsequent lowering of the lactose content. Petersen and Rigor (6) injected lactose solutions into the udder and found tremendous reductions in lactose when removed twelve hours later.

THE PROBLEM

The disappearance of lactose observed by Petersen and Rigor indicated that absorption had occurred, so it was decided to perform similar injections and watch the milk, blood, and urine for changes in sugar content. As the right and left halves of the udder are completely separated, one gland can be used for injection and serve as a constantly draining reservoir. The other gland can be used for a study of the effect upon the milk. As no name has been given to this type of injection, it was decided to use the term "intra-mammary duct injection" throughout this paper.

METHODS

Injections. The intra-mammary duct injections were made through an ordinary teat canula and by means of gravity. The solutions were sterilized and buffered with sodium bicarbonate.

Sampling. Blood, milk and urine samples were collected regularly. Micturition was artificially stimulated whenever samples were to be collected.

Analysis. Milk sugar was determined by the picric acid method according to Bierman and Doan (1), blood sugar and urine sugar according to Shaffer-Hartman (7) on the filtrates prepared according to Folin-Wu (4).

The unfermentable sugars were determined by the same technique after chloroform and yeast treated urine had stood at room temperature for about

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¹ From the Division of Agricultural Biochemistry, University of Minnesota.

² From the Division of Dairy Husbandry, University of Minnesota.

thirty hours. The values obtained from blank determinations of normal urine of similar specific gravity were deducted from the results as a means of correction for the naturally occurring copper reducing substances normally present in cow's urine.

EXPERIMENTAL

The first study consisted of a group of five experiments, the object of which was to determine whether or not it was possible to raise the blood sugar level by the intra-mammary duct injections of sugar solutions of varying strengths and to determine whether hypotonic, isotonic and hypertonic solutions had similar physiological effects. Guernsey cow 538 and Jersey cow 153 were used for this purpose. In Experiment 1, cow 538 was given an intra-mammary duct injection of isotonic glucose, in Experiment 2 an hypertonic glucose injection, and in Experiment 3 a hypotonic glucose solution. In Experiment 4, cow 153 was given an intra-mammary duct injection of isotonic glucose, and in Experiment 5 the same cow was injected with isotonic lactose. The varying details of all these experiments are given in the protocols which accompany the graphically illustrated results of each. The technique was the same in all five experiments and consisted of stripping the gland at the regular morning milking period and then injecting into the right half of the gland a volume of sugar solution equal to that of the milk obtained from it. Blood and urine samples were collected at intervals of about one hour, and the temperature changes of the animal were recorded. No milk was removed from the gland until the regular evening milking period. The results obtained are illustrated in Figures I, II, III, IV, and V. The five preliminary experiments showed clearly that it was quite possible to cause hyperglucemia by the intra-mammary duct injection of sugar solutions, so, further experiments were carried out to determine the practical value of this method in our studies.

In Experiment 6, a solution of hydrolyzed lactose was injected into cow 153, and hourly samples of milk were collected for lactose analysis besides the usual hourly blood and urine samples. In Experiment 7, the same cow was injected with a fructose solution and milk, blood and urine samples collected. The results of these two experiments are graphically illustrated in Figures VI and VII, which are also accompanied by the protocols of the two experiments.

In the experiments already mentioned it was noted that the blood sugar was increased during only a portion of the time. It was, therefore, thought desirable to attempt to produce a hyperglucemic condition for a longer period of time. With this object in mind, three experiments were conducted in which the technique was varied to include a milking out of a certain quantity of the injected solution at about the middle of the experiment and its replacement by the same volume of freshly prepared sugar solution.

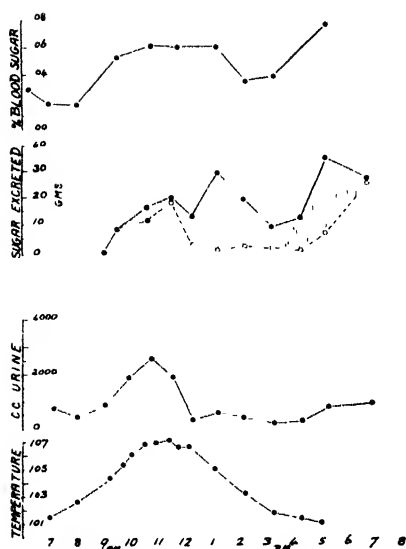


FIG. I. EFFECT OF INTRA-MAMMARY DUCT INJECTIONS OF ISOTONIC GLUCOSE SOLUTION UPON THE BLOOD SUGAR LEVEL. Shaded portion—Unfermentable sugar. o - o - o - o - o—Fermentable sugar.

April 19, 1930. Guernsey Cow 538.

Intra mammary Duct Experiment 1.

Protocol.

Intra-mammary duct injections of 3700 cc. 5.4% glucose into right half gland.

6:10 A.M. Commenced injection, finished at 6:20 A.M.

8:00 " Tremors started.

8:30 " Tremors ceased.

10:00 " Slight twitching over body, hiccough action.

3:45 " Commenced rumination, apparently normal during remainder of experiment.

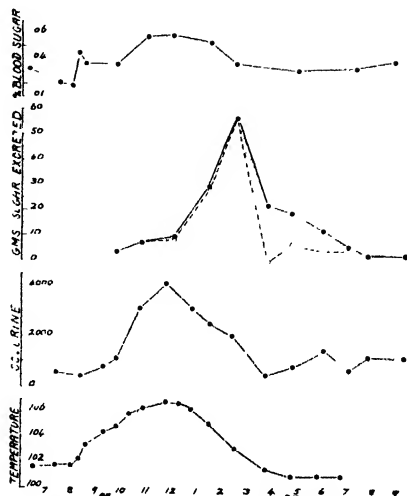


FIG. II. EFFECT OF INTRA-MAMMARY DUCT INJECTIONS OF HYPERTONIC GLUCOSE SOLUTION UPON THE BLOOD SUGAR LEVEL. Shaded portion—Unfermentable sugar. o - o - o - o - o—Fermentable sugar.

April 23, 1930. Guernsey Cow 538.

Intra-mammary Duct Experiment 2.

Intra-mammary duct injections of 3625 cc. 8% glucose, right half gland.

6:45 A.M. Commenced injection, finished at 6:55 A.M.

8:15 " Commenced to quiver in neck.

8:17 " Quivering in flanks.

8:22 " General tremors.

8:23 " Violent tremors.

8:37 " Extremely violent tremors.

8:45 " Tremors spasmodic.

9:15 " Ruminating, animal apparently normal during the remainder of experiment.

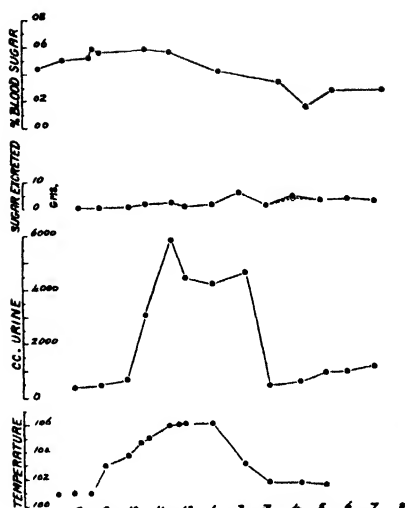


FIG. III. EFFECT OF INTRA MAMMARY DUCT INJECTIONS OF HYPOTONIC GLUCOSE SOLUTION UPON THE BLOOD SUGAR LEVEL. Shaded portion—Unfermentable sugar. —o—o—o— Fermentable sugar.

April 29, 1930. Guernsey Cow 538.
Intra mammary Duct Experiment 3.

Protocol.

Intra mammary duct injection of 4000 cc. 27% glucose, left half gland.
6:35 A.M. Commenced injection, finished at 6:45 A.M.
8:10 " Animal apparently normal.
8:12 " Tremors commenced.
8:22 " Tremors violent.
8:26 " 30 cc. 20% CaCl₂ solution injected.
8:34 " Tremors extremely violent and continuous.
8:43 " Tremors intermittent.
8:47 " Hiccough action.
8:50 " Feeding normally.
10:10 " Hiccough action every five minutes.
10:40 " Slight twitching flanks and thighs.
10:50 " Animal apparently normal during remainder of experiment.

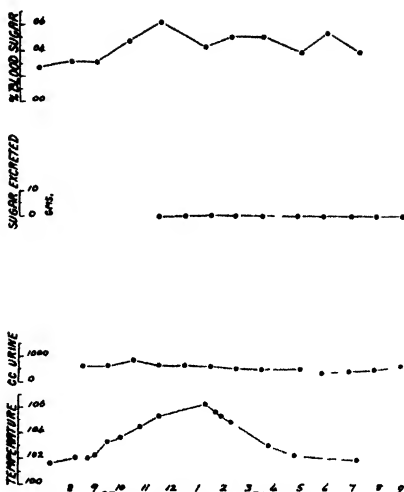


FIG. IV. EFFECT OF INTRA MAMMARY DUCT INJECTIONS OF ISOTONIC GLUCOSE SOLUTION UPON THE BLOOD SUGAR LEVEL. May 1, 1930. Jersey Cow 153.

Intra mammary Duct Experiment 4.
Protocol.

Intra-mammary duct injection of 3900 cc. 54% glucose, left half gland.
6:52 A.M. Commenced injection, finished at 7:10 A.M.
8:25 " Feeding normally.
8:40 " Apparently quite normal.
1:30 P.M. Slight panting.
2:30 " Animal apparently normal during remainder of experiment.

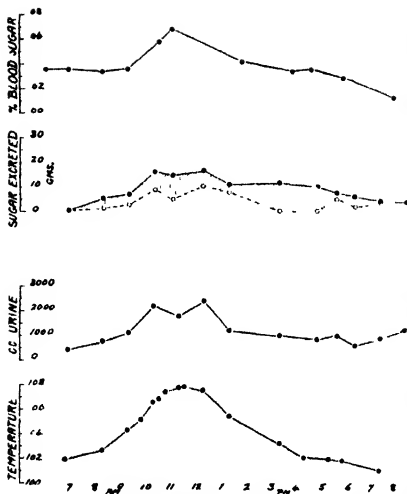


FIG. V. EFFECT OF INTRA-MAMMARY DUCT INJECTIONS OF ISOTONIC LACTOSE SOLUTION UPON BLOOD SUGAR LEVEL.

Shaded portion—Unfermentable sugar.

o—o—o o—o—o—Fermentable sugar

May 6, 1930. Jersey Cow 153.

Intra-mammary Duct Experiment 5.
Protocol.

Intra-mammary duct injection of 4000 cc. 8.8% lactose, right half gland.

6: 45 A.M. Commenced injection, finished at 7: 05 A.M.

10: 25 " Vigorous tremors hind quarters.

10: 33 " Very vigorous tremors

10: 55 " Tremors practically over, intermittent, most of tremors in rear quarters.

10: 57 " Marked twitching between hook and pin bones.

11: 00 " Increased tremors.

11: 05 " Tremors intermittent.

11: 10 " Tremors more marked.

11: 20 " Hiccough symptoms.

11: 22 " Vigorous tremors, easing of hind feet common symptom over whole of above period.

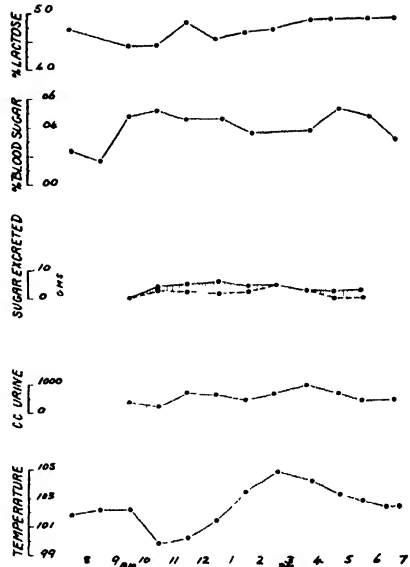


FIG. VI. EFFECT OF INTRA-MAMMARY DUCT INJECTION OF HYDROLYZED LACTOSE SOLUTION UPON THE BLOOD SUGAR LEVEL AND THE LACTOSE CONTENT OF THE MILK.

Shaded portion—Unfermentable sugar.

o—o—o—o—o—o—Fermentable sugar.

November 30, 1930. Jersey Cow 153.

Intra-mammary Duct Experiment 6.

Intra-mammary duct injection of 2500 cc. 6.2% hydrolysed lactose, right half gland.

7: 30 A.M. Commenced injection, finished at 7: 40 A.M.

11: 45 " Momentary twitching of flanks following the taking of blood sample.

11: 47 " Ruminating, apparently normal.

12: 30 " Animal started to ease weight alternately from right to left hind legs, giving a swaying motion to its rear end. Swaying intermittent and of about 30 seconds' duration.

11: 25 " Intermittent tremors,
five second intervals.
11: 30 " Tremors ceased.
11: 40 " Humped back, very
very restless.
11: 45 " Decided tremors
throughout, restless.
11: 50 " Apparently normal dur-
ing remainder of ex-
periment.

2: 00 " Animal apparently nor-
mal during remain-
der of experiment.

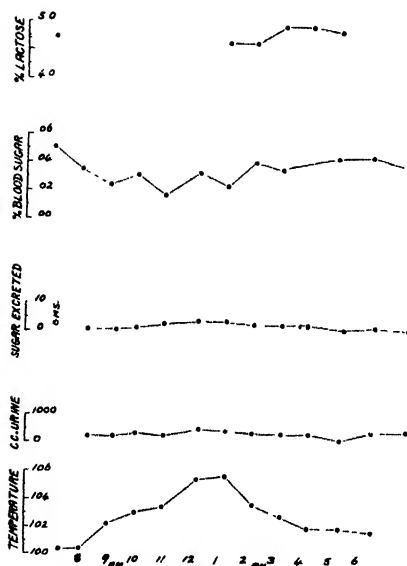


FIG. VII. EFFECT OF INTRA-MAMMARY DUCT INJECTION OF FRUCTOSE UPON THE BLOOD SUGAR LEVEL AND THE LACTOSE CONTENT OF THE MILK.

December 6, 1930. Jersey Cow 153.
Intra-mammary Duct Experiment 7.

Intra-mammary duct injection of 2500 cc. of 5.4% fructose, right half gland.

7: 00 A.M. Commenced injection,
finished at 7: 10 A.M.
Animal apparently nor-
mal during whole of
experiment.

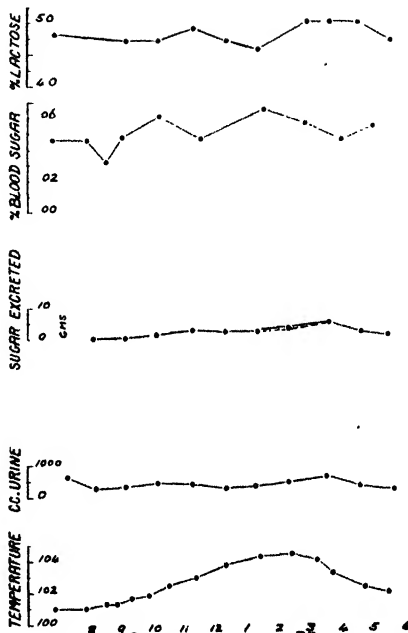


FIG. VIII. EFFECT OF INTRA-MAMMARY DUCT INJECTIONS OF GLUCOSE SOLUTION UPON THE LACTOSE CONTENT OF MILK. Shaded portion—Unfermentable sugar. o—o—o—o—o—Fermentable sugar.

May 13, 1930. Guernsey Cow 538.
Intra-mammary Duct Experiment 8.
Protocol.

Intra-mammary duct injection of 4000 cc. of 5.4% glucose, right half gland.

6: 50 A.M. Commenced injection,
finished at 7: 00 A.M.

7:50 " Animal lying down,
champing jaws.
9:00 " Apparently quite nor-
mal, ruminating.
11:25 " Milked out 2000 cc.
from right half
gland and replaced
it by same quantity
of 10.8% glucose
solution
Animal apparently nor-
mal during remain-
der of experiment.

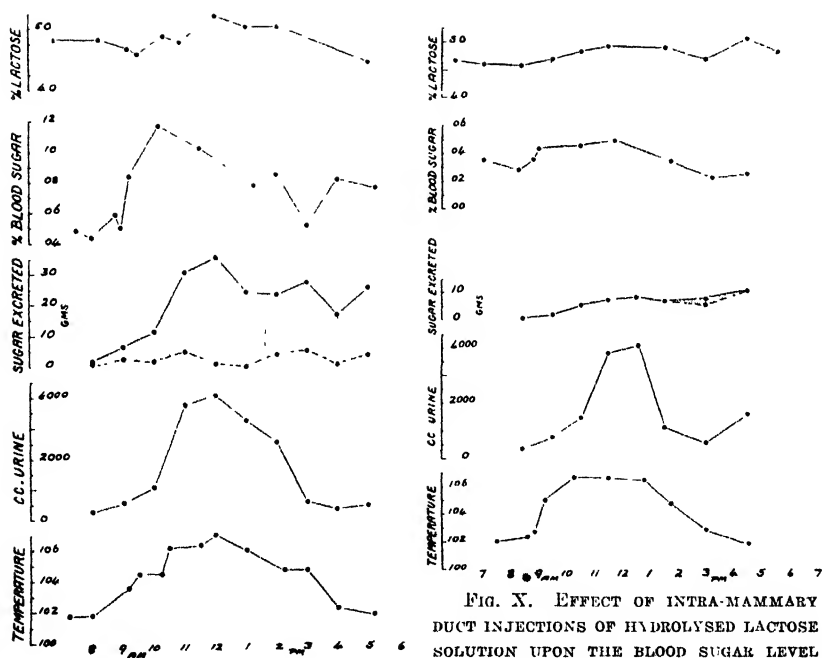


FIG. IX. EFFECT OF INTRA-MAMMARY DUCT INJECTIONS OF LACTOSE SOLUTION UPON THE BLOOD SUGAR LEVEL AND THE LACTOSE CONTENT OF THE MILK.

Shaded portion—Unfermentable sugar.
o—o—o—o—o—Fermentable sugar.

May 19, 1930. Guernsey Cow 538.
Intra-mammary Duct Experiment 9.
Protocol.

Intra-mammary duct injection of

FIG. X. EFFECT OF INTRA-MAMMARY DUCT INJECTIONS OF HYDROLYSED LACTOSE SOLUTION UPON THE BLOOD SUGAR LEVEL AND THE LACTOSE CONTENT OF THE MILK. Shaded portion—Unfermentable sugar.
o—o—o—o—o—Fermentable sugar.

June 10, 1930. Guernsey Cow 538.
Intra-mammary Duct Experiment 10.

Protocol.

Intra-mammary duct injection of
4000 cc. of 6.2% hydrolyzed lactose, right
half gland.

7:00 A.M. Commenced injection,
finished at 7:14 A.M.

4000 cc. of 8.8% lactose, right half gland.	7:40	“	Animal apparently normal.
6:53 A.M. Commenced injection, finished at 7:08 A.M.	8:44	“	Commenced to tremble, shivering quite general and very constant, less spasmodic than usual.
8:00 “ Animal apparently normal.			
8:40 “ Tremors commenced.			
9:10 “ Tremors ceased.	9:08	“	Tremors spasmodic, very strong.
10:30 “ Slight tremors, blood clots easily.	9:12	“	Tremors spasmodic, back arched.
10:35 “ Tremors throughout, marked shivering, hiccough motion, very marked quivering of neck.	9:13	“	Tremors subsiding.
	9:15	“	Tremors stopped.
10:42 “ General tremors.	10:55	“	Animal arched back every few seconds.
10:43 “ Tremors spasmodic.	11:35	“	Milked out 1000 cc. from right half gland and then replaced it by same quantity of 12.6% hydrolyzed lactose solution.
1:10 P.M. Milked out 2000 cc. from right half gland and replaced it by same quantity of 10.5% lactose solution.	11:40	“	Slight tremors, arched back.
Animal apparently normal during remainder of experiment.	11:45	“	Animal apparently normal during remainder of experiment.

In Experiments 8, 9 and 10, cow 538 was thus injected twice with glucose, lactose and hydrolyzed lactose solutions respectively. Blood, urine, and milk samples were collected, and the results obtained are illustrated in Figures VIII, IX and X, along with their accompanying protocols.

As a matter of interest in Experiment 11, 800 units of insulin were injected four hours after the intra-mammary duct injection in order to determine the effect of insulin upon an animal in an hyperglucemic condition from this cause. Figure XI indicates the results obtained.

DISCUSSION OF RESULTS

The considerable variation noted between the blood sugar curves, the urine output, the amount of sugar excreted and the absence or occurrence of tremors, following the intra-mammary duct injections, may be due to differences in the rate of the passage of sugar into the blood stream, individual differences in the manner of disposal of the sugars or to an unrecognizable condition of the animal prior to the commencement of the experiments.

However, in a general way, the blood sugar curves show certain resemblances which, along with the fact that the intra-mammary duct injections have resulted in a pronounced hyperglucemic condition, indicates that the method offers some promise in this and similar problems.

FIG. XI. EFFECT OF INTRA-MAMMARY DUCT INJECTION OF ISOTONIC GLUCOSE SOLUTION UPON BLOOD SUGAR LEVEL AND THE LACTOSE CONTENT OF THE MILK, WHEN FOLLOWED BY THE INTRAVENOUS INJECTION OF 800 UNITS OF INSULIN.

Shaded portion-- Unfermentable sugar.
 o-o-o-o-o-o-o-o-o-o--Fermentable sugar.

May 27, 1930. Guernsey Cow 538.
Intra-mammary Duct Experiment 11.

Protocol.

Intra-mammary duct injection of 4000 cc. of 5.4% glucose solution, right half gland.

7: 19 A.M. Commenced injection, finished at 7: 30 A.M.

9: 25 " Slight tremors.

9: 30 " Tremors ceased.

11: 18 " 800 units insulin injected into jugular vein.

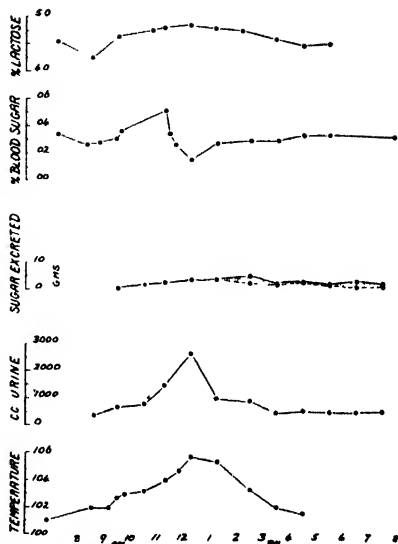
11: 18 " Tremors commenced.

11: 23 " General tremors, not vigorous, back arched, legs under.

11: 38 " Tremors intermittent, hiccough motion.

12: 04 P.M. Tremors ceased.

12: 04 " Feeding normally, apparently normal during remainder of experiment.



The commonest experience was to find that, after an intra-mammary duct injection, the animal remained apparently normal for about ninety minutes but then suddenly became quite restless and immediately passed into a condition of tremors, lasting for approximately one-half hour. The tremors subsided as quickly as they had commenced, leaving the animal apparently normal. The tremors occurred only in seven of the eleven experiments.

The onset of tremors was always (with the exception of those occurring following an insulin injection) closely followed by a marked blood sugar rise, and accompanied by a temperature rise which reached its peak in about four hours. The temperature subsidence to normality was at about the same rate. The temperature rise was always perfectly reflected by the diuresis which accompanied it. While much water was excreted by the animals during the diuresis, no abnormal thirst was noticed.

When no tremors were produced the temperature rise was slower, and the peak of the temperature curve was reached from one to two hours later. In

these experiments no diuresis occurred, although appreciable quantities of sugar were excreted.

The cause for this difference in experimental effect produced in the same animals at different times, because of the appearance or non-appearance of diuresis, appears to lie in a difference in the state of hydration of the animal at the commencement of the experiment.

The tremors are not identical with those of insulin shock, but, as they were produced three times while the blood sugar was either normal or in a slightly hyperglucemic condition and four times during hypoglucemia, the cause is obscure. In spite of this, it nevertheless appears that the blood sugar is somewhere connected with this syndrome because the commencement of the tremors was usually coincident with a marked blood sugar rise.

That the diuresis is not directly caused by the sugar appears probable, because, while this condition was most pronounced in Experiment 3, only traces of sugar were excreted, and again because in those experiments where no diuresis occurred considerable amounts of sugar were nevertheless excreted.

The origin of the tremors as due to a calcium upset is not indicated because in Experiment 3 30 cc. of CaCl_2 were injected into the jugular vein during the tremors, without noticeable effect; and again because in Experiments 8 and 9, hourly blood calcium determinations failed to show any abnormal changes.

While no general abnormality was apparent in the animals following the experiments, the amount of milk secretion was subnormal for four or five days, but after this time the normal amount of secretion returned.

The evidence of Experiments 5 and 9, where the injected sugar, lactose, appeared in the urine within one hour, indicates that the sugar commences to pass into the blood stream very soon after the injection. In spite of this evidence, no marked hyperglucemia occurred in any of the experiments until a much longer period. In seven of the eleven experiments a hypoglucemic condition actually occurred before the hyperglucemia.

A possible explanation of this lag may be that the first appearance of sugar entering the blood initiated an increased insulin activity (or increased glycogen formation), and that a hyperglucemia was not possible until the excess sugar had finally temporarily exhausted the sugar removal mechanism. Contrary to this, as in Experiment 3, when the hypotonic glucose solution was injected, probably so little sugar at first passed into the blood that no increased activity immediately occurred; but when the sugar inflow became greater, the stimulus supplied was more than adequate to take care of the injected sugar so that some of the naturally occurring blood sugar was also removed, and hypoglucemia resulted.

It, therefore, appears as though it is essential to inject more than enough sugar to exhaust the insulin (or retard the glycogen formation) in order to

produce hyperglucemia, or hypoglucemia will occur. In the light of this explanation, the cause of the failure of the intravenous sugar injections becomes apparent.

While an explanation of the general common trend of the blood sugar curves has been attempted, it appears at present advisable to disregard the minor fluctuations occurring in the individual curves and to consider them only with reference to their major points.

As no milk was removed from the gland in the first five experiments, the results of these must be considered separately. In the first four experiments glucose was injected, but in the fifth lactose was used. In Experiment 1, cow 538 was injected with isotonic glucose; in Experiment 2, with hypertonic glucose; and in Experiment 3, with hypotonic glucose.

The first two injections produced quite similar results which included marked tremors, a temperature rise, diuresis, a hypoglucemia followed by hyperglucemia, and an excretion of considerable amounts of an unfermentable sugar which was identified as lactose. In Experiment 3, the results produced were tremors, a temperature rise, a slight hyperglucemia, followed by a pronounced hypoglucemia, and considerable diuresis. No unfermentable sugar was found in the urine. In Experiments 1 and 2 the amount of unfermentable sugar in the urine was greatest after the peak of the hyperglucemia had been reached. While some of the unfermentable sugar may have had its origin in the injected half of the gland, the bulk of it appears to have come from the uninjected portion from which it poured into the blood stream to compensate for the disturbance of equilibrium brought about by the blood sugar drop. While the first two experiments showed this condition most plainly, the same type of excretion was also observed in Experiments 8 and 11. In the two latter cases, the lactosuria is on a much smaller scale because the uninjected half of the gland had been milked out at frequent intervals. That no lactosuria occurred in Experiment 3 is possibly due to the fact that the resulting hypoglucemia had reduced the lactose secretion below the point where it could take active part in an equilibrium interchange.

A second cow, 153, was used in the two remaining experiments of this series. In Experiment 4, isotonic glucose was injected, and in Experiment 5 isotonic lactose. Unfortunately in Experiment 4, while a marked hyperglucemia and temperature rise occurred, the non-appearance of the tremors and diuresis changed the picture so that a comparison with Experiment 1 was difficult.

That the tremors were not an idiosyncrasy of cow 538 was evidenced in Experiment 5 when 153 exhibited an abnormally long period of tremors after a lactose injection. The lactose excreted commenced one hour after the injection, but reached its maximum after the blood sugar peak had been reached.

In Experiment 6, hydrolyzed lactose was injected into cow 153. In this experiment no tremors occurred, but the hyperglucemia was marked and the hourly lactose determinations showed an apparent increased lactose secretion towards the end of the experiment.

The same animal was injected with fructose in Experiment 7, but again no tremors occurred and unfortunately several of the milk samples were accidentally discarded. A qualitative test for fructose failed to show its presence either in the milk or the urine.

Following these experiments, it was thought that the extent and duration of hyperglucemia might be increased by a second sugar injection. With this in view in the next three experiments, part of the contents of the injected half of the gland were milked out at a time estimated to coincide with the maximum hyperglucemia, and replaced by a double strength sugar solution. In Experiment 8, where cow 538 received two injections of glucose, the second injection appeared to increase the hyperglucemia; but in Experiments 9, when lactose was injected, and 10, when hydrolyzed lactose was used, the second injection appeared to reduce the blood sugar. From this experience, it is considered that a second injection is of doubtful value.

In Experiment 11, cow 538 was given a glucose injection and then, when the hyperglucemia was thought to be near its peak, 800 units of insulin were administered intravenously. The insulin injection, which resulted in a pronounced hypoglucemia, was immediately followed by vigorous tremors which commenced and stopped long before the point of maximum hypoglucemia. The hypoglucemia following the insulin injection was reflected in the trend of the lactose secretion during the remainder of the experiment.

After the intra-mammary duct injections, the blood sugar curves are reflected in the lactose curves. These latter curves appear more regular than those usually obtained with normal animals. The most irregular curve of the group is that following the lactose injection, which itself resulted in such marked blood sugar fluctuations.

One noticeable feature of the injections has been that while it is apparently easy to produce hyperglucemia, no matter how large the amount of sugar injected, the blood sugar was only raised appreciably above .060 per cent in one instance when lactose was used. From this it appears as though .060 per cent must be about the renal threshold for the animals used, and that the reason the lactose injection caused such a marked hyperglucemia was because the body could not readily utilize this sugar but instead had to depend entirely upon the kidneys for its removal.

The high, level portions of the lactose curves appear to be the effect of the sugar injections, but the magnitude of the increases was much smaller than was anticipated. From these experiments it is now realized that the demonstration of an increase in lactose is a much more difficult undertaking than that of a decrease. It appears that lactose synthesis has been nicely

adjusted to the average blood sugar level which maintains optimum synthesis. That the optimum synthesis is very close to maximum synthesis appears probable, because while even a slight hypoglycemia tends to depress the lactose secretion, a marked hyperglycemia does not have as great an opposite effect.

The disappearance of the sugar from the blood soon after its passage from the gland indicates a ready utilization in the animal body. Of the sugars injected, glucose, fructose, and galactose are apparently quite easily disposed of without excretion; but the appearance of lactose in large quantities in the urine seems to show that this sugar is not as readily utilized as the more simple ones.

In regard to the question of sugar excretion, it appears as though the efficiency of the various sugar removal mechanisms is affected by very slight changes in the animal's condition, and that the amounts of sugar disposed of by excretion are subject to such wide fluctuations that a quantitative determination is not of much importance.

Incidental to these studies, some additional light seems to have been thrown on the mechanism of the formation of colostrum.

In this connection several former discoveries have been considered along with this work. In the first place, that lactosuria is commonly found just before and immediately following parturition in many species of mammals has long been known. Then Eckles and Palmer (3) discovered that if cows are milked regularly up to the time of parturition the secretion obtained after parturition more nearly resembles normal milk than it does colostrum. Further Jackson and Rothera found that if a portion of milk were returned to the udder after stripping, the next milking produced a secretion very low in lactose but high in ash. Davidson then reported that an incomplete milking tends to decrease the lactose secretion for the two following days, and finally Petersen and Rigor discovered that if a lactose solution were injected into the gland, this lactose had been largely removed from the secretion which was milked out twelve hours later and that its place had been taken by ash. Furthermore, the secretion obtained from the gland for the first two or three days after such an injection more nearly resembled colostrum than it did normal milk.

In these experiments it is indicated that lactose can readily pass from the mammary gland ducts into the blood, and that it does so if the concentration within the gland is above the level of the amount of blood sugar secreting it.

All of the above mentioned observations point to the conclusion that the reason for the lactosuria before and immediately after parturition is that the mammary gland has been secreting normal milk, but that because the elaborated milk has not been removed from the gland, soon after it was formed, a pressure has been built up causing some of the milk constituents

to be broken down, others partially reabsorbed, and in the case of the lactose its resorption and replacement by salts.

Viewed in this light colostrum, therefore, would not be a distinct secretion of the mammary gland, but rather an equilibrium product formed from true milk after the external pressure in the mammary gland ducts has stopped normal milk synthesis.

SUMMARY

1. Intra-mammary duct injections were found to be a practical way of producing hyperglucemia in the bovine.

2. Because the inflow of sugar from the mammary gland apparently stimulates increased insulin activity, sufficient sugar must be injected to exhaust the insulin supply, or hypoglucemia will result.

3. In some cases a marked condition of tremors was produced.

4. Failure to produce tremors in some of the experiments is thought to be due to a partial dehydration of the animals.

5. The onset of a pronounced diuresis accompanied the tremors.

6. The diuresis is thought to be more nearly related to the tremors than to the injected sugar.

7. It appears that a hyperglucemic condition results in a slight increased lactose secretion.

8. The evidence available indicates that colostrum may be an equilibrium product of normally secreted milk rather than a special secretion of the mammary gland.

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INFLUENCE OF PRECEDING DRY PERIOD AND OF MINERAL SUPPLEMENT ON LACTATION

P. T. DIX ARNOLD AND R B BECKER

*Animal Husbandry Department, Florida Agricultural Experiment Station,
Gainesville, Florida*

INTRODUCTION

A number of independent factors affect milk and butterfat production by dairy cows. Previous papers have dealt with the effects of season, advancing lactation and environmental temperatures upon butterfat percentages (4), and of season and advancing lactation upon milk production (3) by Jersey cows. This study deals with length of the dry period and use of bonemeal with low-calcium rations, as factors affecting milk production.

Optimum length of the dry period as it influences subsequent lactation has been determined only under limited conditions. Dairy text-books give recommendations on desirable lengths of dry period, based on general practice and observations rather than on detailed studies of milk records. The latitude and environment of Florida, where the present study was made, differ widely from conditions prevailing in other regions where observations have been recorded.

The common forage crops grown on acid sandy soils in the Coastal Plains have a low content of calcium; consequently it is desirable to use a mineral supplement with them when such roughages are fed to dairy cows. Calcium is one of the elements involved in storage in the skeleton during the dry period.

The two conditions mentioned above made it advisable to analyze local records of milk production to obtain more definite information applicable to this region.

REVIEW OF LITERATURE

Management practices

Ten widely used text-books in dairy husbandry, published between 1911 and 1930, recommend that cows have a dry or rest period ranging from 4 to 10 weeks in length. The majority of texts favored 6 to 8 weeks, depending on the physical condition of the cow. The practice of drying off cows as they approach parturition has been developed from the experience of practical farmers and dairymen over a period of more than a century, rather than based on the results of planned experiments. Culley (9) in 1786 mentioned that cows fattened quickly when they were turned dry. Dickson (10) in 1805 stated that there was a difference of opinion among English farmers of that period—some favoring a two-months' dry period, while others believed periods as short as ten days sufficient.

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Other early writers who favored dry periods of 6 weeks to 2 months include "a Lincolnshire grazier" (1), Flint (12), Le Cornu (15), Le Conteur (16), Linsley (17), Skinner (20) and Youatt and Martin (22).

Alvord (2) stated that six weeks should be the longest time allowed for a cow to be dry before calving. Woodward and Dawson (21) held that the length of dry period should depend on quantity of milk a cow produced and upon her condition as regards fatness. Copeland (8) summarized the Jersey Herd Test records and showed that on the average of all herds, the cows were dry 15.39 per cent of the time, or that the average dry period was of eight weeks' duration.

Gavin (13) analyzed 347 records of dairy cows in an English herd, and found a reduced maximum daily yield for those cows dry less than 35 days. No advantage was gained by cows dry longer than this period. Carroll (6) studied two years' records of a Utah cow testing association, and observed that a long dry period reduced annual yields of butterfat; that for the highest production, a cow needed a longer rest than one month, and that a dry period of more than two months added nothing to the yield of milk and butterfat. The highest average butterfat yield per year and the highest average first-month butterfat yield followed dry periods two months in length.

Hammond and Sanders (14) studied records of 408 cows and noted that cows dry 80 to 119 days gave 14.2 per cent more milk, and cows dry 40 to 79 days gave 10.9 per cent more than did cows dry 39 days or less. They concluded that, "It would appear that a cow's yield is considerably lowered by a very short dry period, but not greatly increased by a very long one."

Mineral supplement

Meigs and Woodward (19) supplied di-sodium phosphate to seven cows during dry periods about two months in length. During the 30 days beginning ten days after calving, 37.9 per cent more milk was produced than in a similar period in the previous lactations. Meigs (18) reported that cows receiving alfalfa hay high in calcium decreased in milk yield less rapidly than did other cows on a low calcium ration containing timothy hay.

Twelve Jersey cows at the Florida station received low-calcium rations over a period of years. The rations of these 12 cows subsequently were supplemented with bonemeal. Milk yields were tabulated for these two periods, and it was observed (5) that there was an increase of 50.16 per cent in total milk production while the cows were receiving the rations adequate in calcium.

STATEMENT OF PROBLEM

Acid sandy soils low in available lime make up a large part of the Gulf Coast and Coastal Plains regions. The lands on which pasture and silage crops were grown for the Jersey cows at the Florida station fall in this class. Roughages grown on these soils supplied an insufficient amount of calcium

to the station cows (5). Prior to 1929, the cows in this herd received mainly home-grown roughages and purchased concentrates. The concentrates consisted principally of wheat bran, cornmeal, cottonseed meal and linseed oil-meal, all low in available calcium. Two per cent of finely ground feeding bonemeal has been added to the mixed concentrates since January, 1929. At the same time a limited amount of alfalfa hay was made available to some of the higher producing cows. Under the earlier feeding practices an unusual proportion of the Jersey cows suffered broken hips and ribs, yet remained fat, and did not yield milk in proportion to the offering of concentrates. Under these conditions, what influence does length of dry period and use of bonemeal exert upon the subsequent milk production of dairy cows?

PLAN OF INVESTIGATION

The complete normal lactation records of all Jersey cows in the station herd were assembled. Lactation curves were tabulated by 10-day periods, including the date of calving as the first day. Milk yields were computed to a uniform age basis, using the factors obtained by Clark (7) on Jersey cows milked twice daily in experiment station herds under other than official testing conditions. These records were divided into five classes according to the length of preceding dry periods. One class comprised initial lactations of heifers. The remaining classes were those of cows dry 30 days or less, 31 to 60 days, 61 to 90 days, and 91 days or more preceding the lactations. Since the rations were changed as regards mineral supplement in January, 1929, and substantial increases in milk yields resulted, the lactations previous and subsequent to the inclusion of bonemeal in the concentrates, are grouped separately. Weighted averages were calculated, combining the same classes in both groups.

PRESENTATION AND DISCUSSION OF RESULTS

A total of 291 complete lactations following normal calving of registered and a few high grade Jersey cows were assembled for study under the plan outlined above. These records were of cows milked twice daily. In a few instances some of the cows failed to conceive and were milked longer than 400 days. Any record after the 400th day was excluded from this study.

The 218 records of milk production on the low calcium rations were divided as follows: 53 initial lactations; 10 of cows dry 30 days or less prior to the lactation; 54 dry 31 to 60 days; 45 dry 61 to 90 days, and 56 dry longer than 90 days. The records obtained while cows received rations adequate in calcium totalled 73, divided into corresponding classes which contained 15, 9, 22, 14 and 13 records, respectively.

The maximum milk yield followed dry periods 31 to 60 days in length, as shown from the weighted averages of each class of records given in Table 1. With adequate calcium, milk production in the class dry 61 to 90 days

was slightly greater than in the 31 to 60 day class. However, too few records are included in the 61 to 90 day class, and the difference of only 188 pounds of milk between these two classes is too small to be significant.

TABLE 1

Influence of length of dry period in relation to milk yields of Jersey cows on low-calcium rations, and on rations adequate in calcium contents

DRY PERIOD	NUMBER OF LACTATIONS	AVERAGE YIELDS PER LACTATION			PERCENTAGE OF BASE YIELD*
		On low calcium rations	On adequate rations	Average	
		<i>pounds</i>	<i>pounds</i>	<i>pounds</i>	<i>per cent</i>
Initial lactation	53	4,632.0			
	15		7,581.6		
	68			5,306.0	91.87
30 days or less	10	4,806.2			
	9		5,926.5		
	19			5,335.6	92.38
31-60 days	54	5,188.1			
	22		7,185.1		
	76			5,775.5*	100.00
61-90 days	45	4,937.7			
	14		7,373.0		
	59			5,468.0	94.68
91 days or more	56	4,690.9			
	13		6,878.0		
	69			5,126.9	88.77
Weighted average	218	4,856.0			
	73		7,092.7		
	291			5,420.9	

* Since a dry period of 1 to 2 months has been recommended popularly, the milk yields for this group were used as a base with which to compare those of other groups.

Requirements for growth, storage, reproduction and maintenance are involved with heifers. They have no depletion of calcium and phosphorus to replace, whereas mature cows have to restore their depleted reserves during the dry period, maintain their bodies, and provide for a foetus. The initial lactations of heifers on rations adequate in calcium were significantly greater than from those on low-calcium rations.

The lactation curves

The combined average lactation curves which show influence of the preceding dry period, weighted by numbers of records, are presented in Figure 1. The initial lactations tended to be more persistent than did the

others. The maximum daily yield of the heifers was lower and the rate of decline more gradual, so that their average daily production after the 265th day was the highest of all classes. The maximum daily milk yield was highest for the class dry 31 to 60 days.

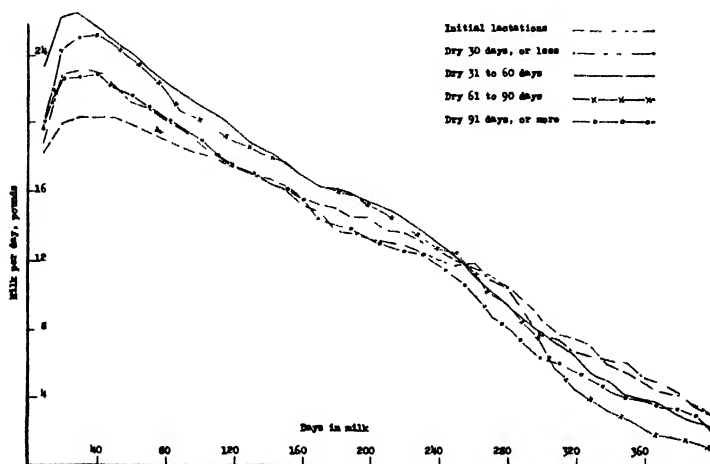


FIG. 1. Relation of length of preceding dry period to milk production of Jersey cows in the Florida station herd.

Cows dry 30 days or less declined more rapidly in daily milk yield up to the 180th day than thereafter. This class, in both the low-calcium and adequate calcium groups, tended to decrease in milk yield less rapidly after the 180th day, up until the expected normal decline due to advancing stage of gestation. It may be interpreted that this more rapid early decline coincides with the period of heaviest withdrawal of stored nutrients (fat and mineral matter) and the flattening of the rate of decline accompanies this time when the daily feed is sufficient to provide all the nutrients for daily milk production. The difference in mineral intake accounts for the difference in level of daily production. The less depleted storage and higher daily intakes of calcium account for the more persistent production toward the close of lactation in the adequate-calcium group. We are unable to state whether or not the exhaustion of internal stimulus (hormones) for milk production occurs at the end of this 180-day period.

The class dry 31 to 60 days had the highest maximum daily production (26.4 pounds), followed by a reasonably uniform rate of decline to the close of the eighth month of lactation, when it dropped off gradually. The classes dry 61 to 90 days, and 91 days or more, parallel each other closely throughout the entire lactations, and were intermediate between initial lactations and those of cows dry 31 to 60 days.

The greatest influence upon the lactation rate resulting from length of dry period appears to be exhibited in the first four months after parturition.

Influence of bonemeal supplement

The relation of the amount of calcium provided by typical rations during these years and the calcium requirements of the cows was discussed in a previous paper (5).

Milk production of 12 Jersey cows studied earlier (5) increased 50.16 per cent in amount as the result of supplementing low-calcium rations with bonemeal. Individuality was not a factor since the milk yields were by identical cows before, and while, using the rations supplemented with bonemeal.

The present study covers all available normal lactations in the station Jersey herd, including the 12 cows mentioned above. Between 1917 and 1928, when the cows were on low-calcium rations, the average production for 218 lactations was 4,856 pounds of milk. Between 1929 and 1932, when the concentrates fed to the cows were supplemented with two per cent of bonemeal, 73 lactations averaged 7,084.5 pounds of milk. These average lactation curves are shown in Figure 2.

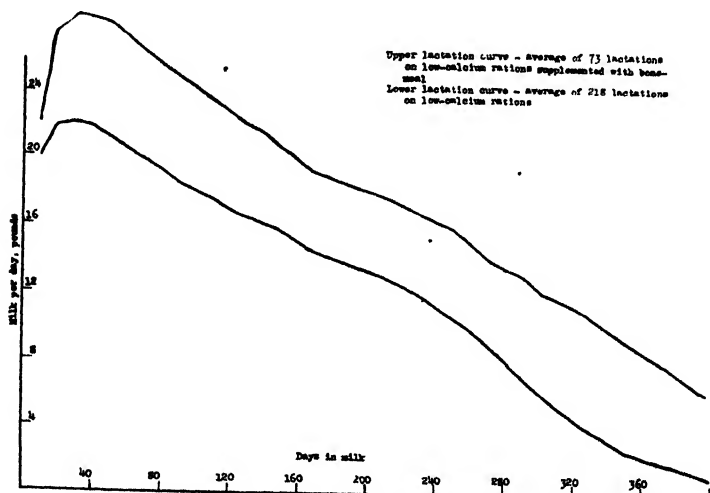


FIG. 2. Average daily milk yields of Jersey cows in the Florida station herd before, and during, the use of bonemeal as a supplement to low-calcium rations. All lactations were computed to a uniform age basis.

Thus it is seen that the increase in milk yield in this case amounted to 45.88 per cent. This compares with an increase of 50.16 per cent in the previous study with identical cows. General feeding conditions other than as regards calcium supply were quite similar in both studies. Increased production for these larger groups is additional evidence that deficiency of

calcium was a limiting factor in milk production, and that bonemeal was a satisfactory supplement to correct the deficiency. It is noted in Figure 2 that the milk yield of Jersey cows was higher at the peak of production, and remained higher throughout the entire lactation, while the cows were receiving rations adequate in calcium. Milk yields of cows on the low-calcium rations decreased more rapidly after the middle of the lactation period than did the yield of cows on the adequate rations.

STATISTICAL ANALYSES

Analyses were made of the differences in the rate of decline in milk production of Jersey cows while on the low-calcium rations, and the adequate-calcium rations, as shown in Table 2. When the χ^2 test of homogeneity and the standard error of difference were calculated,* it was found that the low-calcium lactations had a different rate of decline than did those on the rations adequate in supply of calcium. The chances were less than 1 in 100 that these two rates of decline were identical.

TABLE 2

Average milk production calculated from 218 lactations of Jersey cows on low-calcium rations, and 73 lactations on rations adequate in calcium, at the Florida station between 1917 and 1932

MONTH	PRODUCTION ON LOW CALCIUM RATIONS			PRODUCTION ON ADEQUATE CALCIUM RATIONS		
	Average milk yield	Monthly decrease	Rate of production	Average milk yield	Monthly decrease	Rate of production
	<i>pounds</i>	<i>pounds</i>	<i>per cent</i>	<i>pounds</i>	<i>pounds</i>	<i>per cent</i>
1	639.0		13.16	782.5		16.11
2	637.5		13.13	835.1		17.20
3	580.6	56.89	11.96	769.3	65.86	15.84
4	528.1	52.51	10.88	705.8	63.50	14.53
5	485.6	42.42	10.00	642.4	63.41	13.23
6	436.6	49.02	8.99	578.0	64.35	11.90
7	401.2	35.44	8.26	542.5	35.49	11.17
8	357.6	78.98	7.36	502.6	39.96	10.35
9	294.0	63.64	6.05	448.4	54.13	9.23
10	211.4	82.57	4.35	388.1	60.31	7.99
11	135.6	75.85	2.79	333.8	54.28	6.87
12	82.4	53.14	1.70	274.7	59.16	5.66
13	54.3	28.14	1.12	218.9	55.74	4.51
(10 days)	12.2		0.25	62.4		1.29
Total	4,856.0		100.00	7,084.5		145.88

Differences in average daily milk production on the low-calcium and adequate calcium rations were calculated for both this study and the previous one (5). When these *differences* were graphed in Figure 3 for visual

* These calculations were carried out according to the methods outlined in Chapters 4 and 5 of Fisher (11).

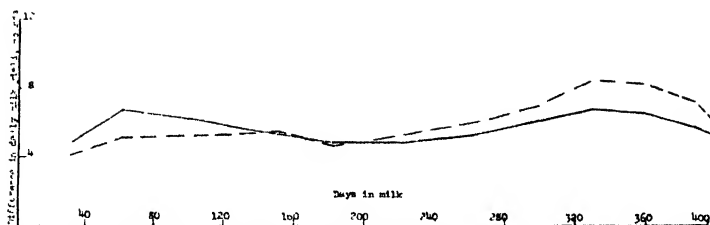


FIG. 3. The broken line represents the average differences in daily milk production between 44 lactations of twelve Jersey cows on low-calcium rations, and 22 lactations on rations adequate in calcium. The solid line represents differences between 218 lactations of Jersey cows on similar low-calcium rations, and 73 lactations on those adequate in calcium, between the years 1917 and 1932. These average daily differences throughout the lactation periods followed a similar trend, and were in excess of four pounds of milk per day.

comparison, again a close similarity was noted in results obtained in the two studies. These differences in milk yield varied slightly in the early months of lactation. They were lower about the sixth and seventh months, and increased after the middle of the lactation. The increasing differences after the seventh month of lactation are believed to be related directly to the stage of depletion of calcium storage and to the intake on the low-calcium rations. Cows on the inadequate rations decreased in milk production more rapidly.

SUMMARY

A dry period of 31 to 60 days has been found in this study to allow maximum milk yields by Jersey cows. A dry period of longer than 91 days appeared to result in lower milk production than did shorter dry periods. Dry periods of less than 30 days appeared to cause an early decline in milk yield, corresponding perhaps to the stage of withdrawal of stored nutrients in the body.

The use of bonemeal as two per cent of the concentrates in supplementing rations that contained roughages grown on acid sandy soils resulted in a 45 per cent increase in milk production with 73 records, over that of 218 lactations on the low-calcium rations.

A statistically significant difference was found in rates of decline in milk production between the groups on low-calcium and on adequate-calcium rations.

ACKNOWLEDGMENTS

The milk records prior to May 15, 1928, were accumulated by Professor John M. Scott, formerly Animal Industrialist and Vice-Director of the Florida Agricultural Experiment Station. Mr. C. R. Dawson aided with the records from 1929 to 1931. Mr. Alex R. Mathers assisted in assembling part of the early records. Statistical analyses were made with the advice

and suggestions of Mr. Bradford Knapp, Jr., Doctors F. H. Hull and L. W. Gaddum.

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THE EFFECT OF CERTAIN FACTORS UPON THE KEEPING QUALITY OF BUTTER

E. S. GUTHRIE, R. J. SCHEIB, AND C. N. STARK

*Laboratory of Bacteriology, New York State College of Agriculture,
Cornell University, Ithaca, New York*

The factors which have been considered in a study of the causes for the spoilage of butter held at temperatures which might permit the growth of microorganisms were: the presence of the natural enzymes of milk; the increase in numbers of certain types of bacteria; the ripening of the cream; and the addition of salt. Quality was determined by scoring the butter on the basis of flavor and odor.

All butters in any series were made from the same cream, the bacteriological content of which was determined. The composition of the butters was controlled by careful chemical analyses. The bacterial content of the fresh, unsalted butter made from raw, sweet cream indicates the quality of the cream used and the precautions taken in making the butter. The numbers and types of bacteria present at the various stages of the holding period were determined on milkfat agar (1, 2), tributyrin agar (3), and skimmilk agar (4), as described in a previous report (5). The importance of these types of microorganisms in the deterioration of milk and dairy products has been observed by previous workers (2, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16).

The hydrolysis of fat by the natural lipase in milk has been shown by Schmidt (17), Rogers and his associates (18, 19), Rice and Markley (20), Nair (21), deTomasi and Sharp (22), Krukovsky (23), and others. Nair mentioned the importance of lipase in the spoilage of milk products. It is agreed by workers in this field that milk lipase is destroyed by heating at 140° F. (62.8° C.) for 10 minutes. Krukovsky has recently shown that a pH of 4.7 or less irreversibly inactivates milk lipase. The effect of salt upon lipase activity is not definitely known. The oxidizing enzymes sometimes present in milk, cream, and butter are known to be inactivated by high acidity and to be destroyed by 170° F. (76.5° C.) for 10 minutes (19, 24, 25, 26).

In the presence of certain microorganisms and at a temperature at which they can grow, the preserving action of acid and salt is well known. In the absence of excessive numbers of microorganisms or at temperatures too low to permit their growth, either acid, or acid and salt, has been shown to hasten the chemical deterioration of butter (27, 28, 29, 30, 31, 32, 33, 34).

During the past two years five different series of butter have been studied. Holding temperatures of 41° F. (5° C.), 50° F. (10° C.), and 75.2° F. (24° C.) have been employed. When all conditions were similar, except the temperature of holding, the quality of all the butters tended to approach the

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TABLE 1
The effect of pasteurization, milk enzymes, acid, and salt upon the keeping quality of butter—series E

DAYS HELD AT 10° C.	NUMBER OF BACTERIA PER GRAM OF BUTTER				CHEMICAL COMPOSITION				JUDGE'S	
	Total	Splitting		Digesting Casein	pH	Per cent		Score on flavor	Criticism	
		Milkfat	Tributyrin			Water	Salt in water			butter
<i>Butter Made from Cream Pasteurized at 165° F. (73.9° C.) for 30 Minutes</i>										
Unsalted butter made from sweet cream										
0	100	<10	<10	<10	6.60	13.08		40		
9	120,000	900	40,000	7,000				38		
21	440,000	3,800	39,000	<10				38		
36	100,000	<10	50,000	<10		12.24		37	sl. old	
Salted butter made from sweet cream										
0	100	0*	0	0	6.60	12.95	13.91	2.09	40	
9	400	0	0	0					37	oily
21	300	0	0	0					37	oily
36	1,700	0	0	0		11.43	15.21	2.05	36	oily
Unsalted butter made from sour cream										
0	6,900,000	0	0	0	4.61	13.90			40	
9	1,800,000	0	0	0					38	
21	378,000	0	0	0					38	
36	140,000	0	0	0		12.88			36	stale
Salted butter made from sour cream										
0	950,000	<10	<10	<10	4.61	13.06	14.46	2.21	40	
9	6,900	<10	<10	<10					37	oily
21	500	400	200	500					35	oily
36	1,000	100	100	500		12.33	16.07	2.36	30	oily

TABLE 1—(Continued)

NUMBER OF BACTERIA PER GRAM OF BUTTER				CHEMICAL COMPOSITION				JUDGE'S	
DAYS HELD AT 10° C.	Total	Splitting		Digesting Casein	pH	Per cent		Score on flavor	Criticism
		Milkfat	Tributyrin			Water	Salt in water | butter		
Butter Made from Raw Cream									
Unsalted butter made from sweet cream									
0	13,000	<10	600	<10	6.35	13.09		37	
9	480,000	8,000	160,000	<10				28	bitter
21	960,000	11,000	160,000	2,600				30	old
36	430,000	1,900	80,000	1,000		12.65		28	strong
Salted butter made from sweet cream									
0	12,000	0	500	0	6.35	13.16	14.14	37	
9	9,600	0	5,000	0				31	rancid
21	40,000	0	18,000	0				31	old
36	54,000	0	20,000	0		11.14	16.93	29	stale
Unsalted butter made from sour cream									
0	7,700,000	0	0	0	4.40	13.63		37	
9	330,000	0	0	0				37	old
21	185,000	0	0	0				36	old
36	130,000	0	0	0		13.03		35	old
Salted butter made from sour cream									
0	980,000	0	0	0	4.40	13.14	14.49	37	
9	1,000	0	0	0				32	strong
21	600	0	0	0				30	fishy
36	100	0	0	0		11.41	17.14	29	fishy

TABLE 1—(Continued)

DAYS HELD AT 10° C.	NUMBER OF BACTERIA PER GRAM OF BUTTER				CHEMICAL COMPOSITION				JUDGES	
	Total	Splitting		Digesting Casein	pH	Per cent		Score on flavor	Criticism	
		Milkfat	Tributyrin			Water	Salt in water butter			
<i>Butter Made from Cream Pasteurized at 145° F. (62.8° C.) for 30 Minutes</i>										
Unsalted butter made from sweet cream										
0	100	0	0	<10	6.59	12.63		40	old	
9	13,000	0	0	6,000				38	old	
21	304,000	0	0	0				37	old	
36	13,000	0	0	0		11.49		30	stale	
Salted butter made from sweet cream										
0	100	0	0	0	6.59	11.91	14.78	40		
9	100	0	0	0				37	oily	
21	100	0	0	0				37	oily	
36	100	0	0	0		11.19	15.86	33	old	
Unsalted butter made from sour cream										
0	3,400,000	0	0	0	4.64	13.13		40		
9	1,000,000	0	0	0				38		
21	508,000	0	0	0				38		
36	131,000	0	0	0		11.83		36	oily	
Salted butter made from sour cream										
0	2,100,000	0	0	0	4.64	14.08	13.20	40		
9	7,800	0	0	0				38		
21	300	0	0	0				37		
36	100	0	0	0		12.52	15.33	35	oily	

* 0 Actually means less than 10 bacteria per gram of butter.

same level; the rate of spoilage was faster at the higher temperature and slower at the lower temperature. Since the data obtained on two lots of butter, Series D and E, held at 50° F. (10° C.) illustrate the principles involved in all of the series held at the various temperatures, only these results are presented. These data have more practical value because of the proximity of 50° F. (10° C.) to the temperature found in ice-boxes and refrigerators in grocery stores and homes.

The results obtained from a study of butter, Series E (Table 1), indicate that practically all of the natural milk enzymes are destroyed by 165° F. (73.9° C.) for 30 minutes. Inasmuch as this unsalted butter made from sweet cream was not at any time found to contain large enough numbers of bacteria to be of practical significance, this butter illustrates keeping quality in the absence of all spoilage factors considered in this study. The score at the end of 36 days was 37, the judge considering the butter to be only slightly old. When salt was added to some of this fresh butter, the final score was 36 with a criticism of oily, showing the slightly harmful effect of salt. Butter made from the same cream soured was found to have approximately the same keeping qualities as the salted sweet cream butter. The combined and increased deteriorating effect of salt and acid is easily observed by the low score, 30.

The quality of butter made from the same cream unpasteurized shows very clearly the rôle played by natural milk enzymes in the spoilage of butter; it is believed that the numbers of bacteria in the raw, sweet cream, unsalted butter are too small to be of any great significance, and that the difference between the scores 37 and 28 is due to the action of natural milk enzymes in the butter made from unpasteurized cream. When salt was added to some of this fresh butter made from raw, sweet cream, the final score indicated that salt did not prevent the action of milk enzymes. The difference in score between 36 and 29 is believed to be due to milk enzyme activity in the salted butter made from raw, sweet cream. The score given to the sour cream butter, 35 at the end of 36 days holding, shows that acid inhibits the action of milk enzymes. As would be expected, the salted, sour cream butter deteriorated more rapidly and more completely.

It is known that pasteurization at 145° F. (62.8° C.) destroys lipase and removes certain more volatile substances, but that it does not destroy certain other milk enzymes. These facts explain the final flavor scores: 28 for raw, sweet cream, unsalted butter; 30 for 145° F. (62.8° C.) sweet cream, unsalted butter; and 37 for 165° F. (73.9° C.) sweet cream, unsalted butter.

The effect of salt upon the action of milk enzymes is not well understood. The data here presented lead one to believe that salt does not inhibit (stop) lipase action, but that it does retard (slow down) the action of enzymes which resist the 145° F. (62.8° C.) pasteurization. These statements are substantiated by a comparison of these scores: 36 for 165° F. (73.9° C.)

TABLE 2
The effect of pasteurization, milk enzymes, acid, and salt upon the keeping quality of butter—series D

DAYS HELD AT 10° C		NUMBER OF BACTERIA PER GRAM OF BUTTER				CHEMICAL COMPOSITION					JUDGE'S	
Total		Splitting		Digesting Casein	pH	Per cent			Score on flavor	Criticism		
		Milkfat	Tributyrin			Water	Salt in water	butter				
<i>Butter Made from Cream Pasteurized at 165° F. (73.9° C.) for 30 Minutes</i>												
Unsalted butter made from sweet cream												
0	500	<10	100	100	6.59	19.45				40		
9	58,000,000	18,000,000	14,000,000	18,000,000						38		
21	138,000,000	41,000,000	3,600,000	138,000,000						34	stale	
36	29,800,000	28,400,000	900,000	29,800,000						28	stale	
Salted butter made from sweet cream												
0	50	0*	0	0	6.59	13.20	13.50	2.06		40		
9	56	0	0	0						38.5		
21	14,200	0	0	0						36.5	old	
36	1,800,000	0	0	0						36	old	
Unsalted butter made from sour cream												
0	6,700,000	0	0	0	4.72	14.93				40		
9	3,200,000	0	0	0						38		
21	920,000	0	0	0						37	old	
36	350,000	0	0	0						36	old	
Salted butter made from sour cream												
0	60,000	0	0	0	4.72	13.85	14.40	2.33		40		
9	34,000	0	0	0						37.5	metallic	
21	15,000	0	0	0						36	oily	
36	5,000	0	0	0						33	fishy	

TABLE 2—(Continued)

DAYS HELD AT 10° C.	NUMBER OF BACTERIA PER GRAM OF BUTTER				CHEMICAL COMPOSITION					JUDGE'S	
	Total	Splitting		Digesting Casein	pH	Per cent			Score on flavor	Criticism	
		Milkfat	Tributyrin			Water	Salt in				
							water	butter			
Butter Made from Raw Cream											
Unsalted butter made from sweet cream											
0	1,850,000	170,000	340,000	179,000	6.55	14.78			40		
9	8,000,000	1,760,000		3,000,000					33	rancid	
21	7,000,000	800,000		600,000					28	stale	
36	9,900,000	6,500,000	1,400,000	2,400,000					28	stale	
Salted butter made from sweet cream											
0	490,000	0	20,000	400,000	6.55	15.13	15.19	2.71	40		
9	250,000	0	3,000	160,000					36	old	
21	394,000	0	10,000	34,000					30	old	
36	586,000	0	17,000	31,000					30	rancid	
Unsalted butter made from sour cream											
0	3,030,000	0	4,500	0	4.70	15.37			40		
9	6,200,000	0	0	0					36.5	old	
21	2,610,000	0	0	0					35	old	
36	1,980,000	0	0	0					35	old	
Salted butter made from sour cream											
0	35,000	0	8,300	0	4.70	13.96	13.45	2.17	40		
9	1,980	20	0	0					37	old	
21	1,500	0	0	0					34	oily, old	
36	1,200	0	0	0					31	oily	

TABLE 2—(Continued)

DAYS HELD AT 10° C.	NUMBER OF BACTERIA PER GRAM OF BUTTER				CHEMICAL COMPOSITION					JUDGE'S	
	Total	Splitting		Digesting Casein	pH	Per cent			Score on flavor	Criticism	
		Milkfat	Tributyrin			Water	Salt in water	butter			
<i>Butter Made from Cream Pasteurized at 145° F. (62.8° C.) for 30 Minutes</i>											
Unsalted butter made from sweet cream											
0	60	0	0	0	6.66	15.54			40		
9	4,800,000	0	0	0					37	old	
21	19,200,000	10,300,000	0	10,300,000					28	stale	
36	560,000	0	0	0					28	stale	
Salted butter made from sweet cream											
0	100	0	0	0	6.66	13.48	13.32	2.07	40		
9	120	0	0	0					37	old	
21	100	0	0	0					33	old	
36	1,600	0	0	0					32	old	
Unsalted butter made from sour cream											
0	5,900,000	0	0	0	4.74	13.86			40		
9	3,700,000	0	0	0					37	sl. metallic	
21	840,000	0	0	0					35	sl. metallic	
36	360,000	0	0	0					34	stale	
Salted butter made from sour cream											
0	13,000	0	0	0	4.74	14.16	13.26	2.16	40		
9	2,400	0	0	0					37.5	oily	
21	100	0	0	0					34	oily	
36	300	0	0	0					33	fishy	

* 0 Actually means less than 10 bacteria per gram of butter.

(lipase and oxidase were destroyed by heat) sweet cream, salted butter; 33 for 145° F. (62.8° C.) (lipase destroyed by heat, oxidase present) sweet cream, salted butter; and 29 for raw, sweet cream, salted butter (lipase and oxidase present).

The data presented in this study and results obtained by other workers indicate that high acidity definitely inhibits the action of milk enzymes. A comparison of the scores obtained on sour cream unsalted butters, 36 for 165° F. (73.9° C.) (no lipase or oxidase present), 36 for 145° F. (62.8° C.) (lipase absent, oxidase present) and 35 for raw (both lipase and oxidase present) (Table 1), confirm these observations.

The data obtained from a study of Series D butter are shown in Table 2. These results are presented to confirm the observations and interpretations reported on Series E butter, and to show the effect of bacterial action on butter in the absence of natural milk enzymes. The difference between the final scores of 37 on 165° F. (73.9° C.), sweet cream, unsalted butter (Table 1), and 28 on 165° F. (73.9° C.), sweet cream, unsalted butter (Table 2), is believed to be due to the action of the bacteria upon the constituents of the butter. Heat resistance tests made on these bacteria showed that they were destroyed by 145° F. (62.8° C.) for 30 minutes, which indicates recontamination after pasteurization. The increase in their numbers during the holding period proved their ability to grow in butter. The deteriorating effect of casein digesting bacteria is also indicated on one sample (after 21 days holding) of unsalted butter made from sweet cream pasteurized at 145° F. (62.8° C.) for 30 minutes. In the absence of other spoilage factors, a direct correlation seems to exist between the numbers of fat splitting and casein digesting bacteria present and the spoilage of the butter held at temperatures which will permit the growth of bacteria.

DISCUSSION

Attention might be called again to the fact that only a small percentage of the data accumulated have been presented in this report, but that all the available data confirm the findings presented. It should also be mentioned that bacterial spoilage of butter while stored under commercial conditions is recognized to be of only minor importance; but that the importance of spoilage due to the growth of certain types of bacteria in butter previous to and after removal from commercial storage should not be minimized. Since the keeping quality of butter is affected by so many factors, no direct comparison between the score of the butter and the holding temperatures was possible. In general terms, however, the higher the holding temperature the more rapid was the spoilage of the butter.

These data show that butter having the best keeping quality was unsalted and made from sweet cream pasteurized at 165° F. for 30 minutes. Probably 200° F. by the flash process would be required to accomplish results

equal to 165° F. for 30 minutes. Since the numbers of bacteria were so small, it is not possible to make a definite statement as to whether recontamination occurred in the pasteurized cream previous to or during the butter-making process, or while the butter was being printed. It is also not known whether recontamination of butter by bacteria capable of causing spoilage would occur more frequently in butter made under experimental or commercial conditions. But it is believed that the importance of butter spoilage due to recontamination, after pasteurization, by bacteria which can cause spoilage should not be overlooked.

SUMMARY

The effect of natural milk enzymes, bacteria, acid, and salt upon the keeping quality of butter held at temperatures which might permit the growth of bacteria, has been studied.

Five series of butter consisting of five hundred seventy-six samples, made and held under known and carefully controlled conditions, have been examined.

The results obtained and the data presented seem to justify the following conclusions:

1. Pasteurization of cream at 165° F. (73.9° C.) for 30 minutes destroys most, if not all, of the harmful natural milk enzymes.
2. All milk enzymes harmful to the keeping quality of the butter were not destroyed by pasteurization of the cream at 145° F. (62.8° C.) for 30 minutes.
3. The action of milk enzymes in butter was retarded little, or none, by salt.
4. The action of milk enzymes in butter was definitely inhibited by pH 4.7, or less.
5. None of the non-spore-producing bacteria, found to be of importance in the spoilage of butter, were able to survive 165° F. (73.9° C.) for 30 minutes.
6. In the absence of other spoilage factors, a direct correlation seems to exist between the number of fat splitting and casein digesting bacteria and the keeping quality of the butter.
7. The well known inhibiting action of acid and salt upon the growth of bacteria in butter was confirmed.
8. The presence of either acid or salt in butter, not containing other spoilage factors considered in this study, resulted, after storage, in a poorer quality butter.
9. The combined deteriorating effect of both acid and salt was shown.
10. As would be expected, all butters examined spoiled more rapidly at the higher holding temperatures.

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EFFECT OF LIPOLYSIS ON THE CHURNABILITY OF CREAM OBTAINED FROM THE MILK OF COWS IN ADVANCED LACTATION

V. N. KRUKOVSKY AND PAUL F. SHARP

Department of Dairy Industry, Cornell University, Ithaca, N. Y.

The long churning time which is often encountered in cream separated from the milk of cows in advanced lactation is usually attributed to the small size of the fat globules. This explanation was indicated by Van Slyke (6), and since then has been generally accepted. Hunziker, Mills and Spitzer (3) performed direct experiments from which they concluded that small fat globules require a longer churning time than large ones.

Palmer (4), on the other hand, as a comment to his studies of the lipolytic activity of the milk of cows in advanced lactation, said that the lengthening of the churning time of such cream might be explained as due to the formation of soaps from fatty acids liberated by lipolysis. This explanation has been accepted by Eekles, Combs and Macy (2). If lipase activity is of importance, this type of churning difficulty should be influenced greatly by the temperature of separation of the milk and by immediate pasteurization. (See Sharp and de Tomasi (5) for a discussion of the effect of these factors on lipase activity.)

EXPERIMENTAL

Milk from cows in advanced lactation was held below 5° C. for 24 hours in order to solidify the fat in the fat globules. Then the milk was divided into two parts. One part was separated at 10–15° C. with the fat globules in the solid state, and the other at 45–50° C. with the fat globules in the liquid state. The milk was separated by centrifuging in glass tubes. The cream was standardized with its own skim milk. After being held at 5° C. for 24 hours, each lot of cream was subdivided. One part was churned at once, one part was held for an additional 24 hours before churning, and one part was heated to 70° C. and held cold for an additional 24 hours before churning.

The churning was accomplished by placing 25 ml. of cream in 75 ml. test tubes and shaking the test tubes in a machine. The shaking machine was placed in a room with a temperature between 14 and 17° C. The percentage increase in volume of cream during churning was recorded. In most instances the titratable acidity at the time of churning was determined. Sanitary precautions were observed so that at the end of the experiments the bacterial counts were under 10,000 per ml.

The data which are presented in Table I show quite clearly that the cream

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TABLE I
Effect of temperature of separation on the foaming and churning time of cream from the milk of cows in advanced lactation
 Temperature of churning 14°-17° C.

COW	SEPARATION TEMPERATURE	HEAT TREATMENT OF CREAM	CREAM HELD BEFORE CHURNING	ACIDITY AS LACTIC ACID	TIME OF CHURNING—MINUTES															
					10	15	20	25	30	35	40	45	50	55	60	65	70			
					Per cent increase in volume over that at start															
No.	° C.		hrs.	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%		
1	Cream: 34.00% fat	10°-15° Raw	24	.23	70	70	70	70	70	50	50	40	20	Butter	70	70	70	70**		
		10°-15° Raw	48	.325	85	85	85	85	85	85	85	70	70	70	70	70	70			
		10°-15° Heated*	48	.20	70	70	85	40	20	20	20	20	Butter	Butter	Butter	Butter	70**			
		45°-50° Raw	24	.15	20	20	20	20	20	20	20	20	20	Butter	Butter	Butter	Butter			
		45°-50° Raw	48	.16	20	20	20	20	20	20	20	20	20	Butter	Butter	Butter	Butter			
2	Cream: 31.00% fat	10°-15° Raw	24	.32	85	85	85	85	85	85	85	70	70	70	70	70	70	70**		
		10°-15° Heated*	48		55	55	55	55	55	55	55	55	55	55	55	55	55	55**		
		45°-50° Raw	24	.15	40	40	40	20	20	20	20	20	Butter	Butter	Butter	Butter	Butter	Butter		
		45°-50° Heated*	48		40	40	20	20	20	20	20	20	Butter	Butter	Butter	Butter	Butter	Butter		
		3	Cream: 30.00% fat	10°-15° Raw	24	.19	40	40	40	40	40	40	20	Butter	40	40	40	Butter	Butter	
10°-15° Raw	48			.23	40	40	40	40	40	40	40	40	40	40	40	40	40	Butter		
10°-15° Heated*	48			.18	20	20	20	20	20	20	20	20	20	20	20	20	20	Butter		
45°-50° Raw	24			.14	40	40	40	20	20	20	20	20	Butter	Butter	Butter	Butter	Butter	Butter		
45°-50° Heated*	48				7	7	7	7	7	7	7	7	7	7	7	7	7	Butter		

* Heated 24 hours after separation.

** Not churned at the end of 2 hours.

from milk separated at 45–50° C. churned in a much shorter time and foamed less than the cream separated at 10–15° C. A difference in titratable acidity and a marked difference in butyric acid odor were observed. It should be remembered that the milk had stood for 24 hours before it was separated, during which time considerable lipolysis had occurred. Pasteurization had a beneficial effect, particularly in the case of the cream separated at 10–15° C., which was held for an additional 24 hours before churning.

A second series of experiments was performed in which the milk immediately after milking was divided into two parts. One part was pasteurized; the other was not. Both parts were held below 5° C. for 24 hours and were then separated by centrifuging in glass cups at 10–15° C. The cream thus obtained was divided into parts which were heated, churned at once, or held an additional 24 hours before churning, as indicated in Table II. Table II shows that if the milk is pasteurized immediately after milking, the cream obtained by separation at a low temperature churns readily, with no abnormal foaming, and shows no increase in acidity on holding, neither does it develop the odor of butyric acid.

These experiments indicate that no particular difficulty should be encountered in churning cream from the milk of cows in advanced lactation, if the milk is pasteurized or heated soon after it is drawn, or the milk is separated at once, with the fat in the liquid state, and the cream immediately pasteurized.

The application of this principle is not confined to the difficulty, often encountered on the farm, in churning the cream from one or two cows but is the basis for the practice adopted by some milk plants, particularly in the winter months, of immediately separating the milk and at once pasteurizing the cream before shipping it to the buttermaking plant. This practice has been found to aid in preventing long churning times, excessive foaming, and the rancid flavor of the butter.

Since normal raw cream contains a small amount of lipase it is possible that a part of the effect of pasteurization in shortening the churning time of normal cream is due to the destruction of lipase, particularly in view of the fact that the agitation of the raw cream in churning may greatly increase its activity.

The data of a third experiment in which the factor of ripening was introduced are presented in Table III. Fresh milk was divided into two parts. One part was pasteurized. Both were held at 5° C. for 24 hours and were separated at 20–25° C. in a small cream separator. The cream was standardized to 30 per cent of fat. One-half of the cream separated from the raw milk was inoculated with 1 per cent of starter and incubated at 18° C. for 18 hours, after which it was cooled to 0° C. for four hours prior to churning. The second part of the cream separated from the raw milk, as well as the cream separated from the pasteurized milk, was cooled and held at 5° C. for

TABLE II
Effect of pasteurization on the foaming and churning time of cream from the milk of cows in advanced lactation
 Temperature of churning 14°-17° C. Cream 30 per cent fat.

cow	HEAT TREATMENT		CREAM HELD BEFORE CHURN- ING	ACIDITY AS LACTIC ACID CREAM	TIME OF CHURNING—MINUTES															
	Milk prior separation	Cream			Per cent increase volume over that at the start															
No.			hrs.	%	10	15	20	25	30	35	40	45	50	55	60	65	70	75		
4	Raw	Raw	24	.38	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
	Raw	Raw	48	.45	40	50	70	70	70	70	70	70	70	70	70	70	70	70	70***	%
	Raw	*Heated	48	.30	50	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70***
	Heated	none	24	.13	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40***
5	Raw	Raw	48	.13	Butter	Butter														
	Raw	**Heated	24	.195	50	50	50	40	20	Butter										
	Raw	none	24	.100	20	20	Butter													
	Heated	none	48		20	Butter														
6	Raw	Raw	24	.22	40	40	40	40	Butter											
	Raw	Raw	48	.26	50	50	50	50	50	50	40	Butter								
	Raw	**Heated	24	.11	Butter	Butter														
	Heated	none	48		Butter	Butter														
7	Raw	Raw	24	.15																
	Raw	**Heated	24	.09	Butter	Butter														
	Heated	none	24		Butter	Butter														

* Standardized cream was held for 20 hours prior to pasteurization.

** Pasteurized immediately after separation.

*** Not churned at the end of 2 hours.

TABLE III
Effect of lipase activity on the churning time of ripened 30% fat cream

CREAM SEPARATED FROM	Pasteurized milk	Raw milk	Raw milk
Starter added	none	1.0%	none
Acidity before churning	.11	.28	.25
Churning time—minutes	24	42	60
Butter flavor	good	fair	rancid

the 22 hours prior to churning. Aliquots of 700 grams of each cream were measured into each of three glass churns surrounded by a water bath maintained at 15–16° C. After tempering for one hour the creams were churned. The data are presented in Table III. The cream from the pasteurized milk churned in the shortest time. The acidities of the two samples of raw cream were not greatly different. They differed greatly, however, in the types of acid present. The developed acidity of the sample to which the starter had been added was due largely to lactic acid, whereas that of the sample to which no starter was added was due entirely to fatty acids liberated by lipolysis. Although evidence will be presented in a later paper by de Tomasi and Sharp it will aid in understanding this difference in acidity if it is mentioned that at this temperature range, with such cream, lipolysis is inversely proportional to the temperature, so that little lipolysis would occur at 18° C., while the action is very marked at 5° C. This difference is reflected in the churning time and the odor of the cream during churning.

The data in Table III show that the lipolysis which occurred while the milk was held cold before the cream was separated was sufficient to lengthen appreciably the churning time and even to counteract the shortening of the churning time which one would expect due to the development of acid.

Table IV gives an idea of the lipolytic activity of the different milks used. The increases in acidity are due to lipolysis and not to bacterial action. In general the relative differences in increase of acidity are correspondingly reflected by the lengthening of the churning times of the raw creams in Tables I and II.

As noted in Tables I and II the creams foamed greatly if appreciable lipolysis had occurred. The foam was of a different physical appearance from the foam usually formed in churning. The fatty acids and soaps probably displaced the normal foam constituents at the plasma-air interface, so that coagulation did not occur and the foam maintained its stability.

In churning raw cream from cows in advanced lactation we not only have the effect of the fatty acids which have been liberated at the time the churning is started, but we have an increase in fat hydrolysis during churning due to the accelerative action of shaking on lipolysis. Behrendt (1922) showed that shaking greatly accelerated the lipolysis of human milk but

TABLE IV
Increase in titratable acidity due to lipase action of samples of whole milk used in tables I and II

SAMPLES	FAT WHOLE MILK	PER CENT ACIDITY EXPRESSED AS LACTIC ACID		
		Hours held at 0° - 5°C.		
		0	24	48
	%			
1	7.4	.168	.195	.205
2	7.1	.170	.200	.260
3	4.0	.167	.185	.185
4	6.5	.180	.200	.225
5	4.8	.140		.165
6	4.6	.160	..	.205
7	3.5	.125		.145

had no effect on lipolysis of cow's milk. We have found, however, that shaking does have a great accelerating effect on the lipolysis of raw milk from cows.

SUMMARY

1. The difficulty in churning and the abnormal foam formation found in cream obtained from the milk of cows in advanced lactation is probably due largely to lipolytic action and the concentration of the resultant soaps and fatty acids in the air-plasma interface.

2. Less difficulty in churning and less lipolytic action are encountered if the cream is separated while the fat globules are in a liquid state as contrasted to the solid state.

3. Pasteurizing the milk or cream as soon as drawn largely prevents the difficulty in churning.

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THE DIGESTIBILITY AND FEEDING VALUE OF RUSSIAN THISTLE HAY¹

H. W. CAVE, W. H. RIDDELL AND J. S. HUGHES
Kansas Agricultural Experiment Station, Manhattan

INTRODUCTION

The Russian thistle (*Salsola testifer* Aven Nelson) is a summer annual herbaceous plant usually appearing in May or June. The young plants have slender, fleshy leaves and are grazed readily by cattle and sheep for several weeks, or until they become coarse and spiny.

The Russian thistle appeared in the United States in South Dakota about 1873 or 1874 (1), presumably being brought from Russia in flaxseed. Since its introduction it has spread over a large area in both the United States and Canada. It is very drought resistant and for this reason has made its greatest headway in semiarid regions.

Although called a thistle, due to the spiny tips on the leaves of the more mature plants, it actually belongs to the goosefoot family. Because of the fact that it commonly breaks loose from the ground and rolls long distances it is often called a tumbleweed. The plant puts out many branches near the ground level and as it matures these branches curve inward giving it a ball like shape. It has a small tap root which is easily broken loose by the wind after the plant matures. In the fall of a dry year it is not unusual to see piles of the plants several feet high drifted against the fence rows.

In size the Russian thistle plant varies from one to three feet in height and from one to five feet in diameter. It is estimated that one plant may bear as many as 200,000 seeds. As the plant rolls with the wind these seeds are sown over a wide area.

The Russian thistle is not normally a factor in Kansas either as a feed or a weed pest except in the western half of the state. For many years it has been used for both pasture and hay in that section during times of drought and feed shortage. This was especially true during the past year when many sections had no feed except Russian thistle. An estimate made in 50 western Kansas counties in October, 1934, indicated that there was available for feeding a total of about 400,000 tons of thistles. About nine-tenths of this was in the form of hay and one-tenth in the form of silage.

In chemical composition the Russian thistle varies widely, depending on the stage of maturity. The protein content is high compared with most non-legume roughages. A protein content of over 20 per cent (2) has been

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reported in young plants but the highest protein content of any sample analyzed at the Kansas Station during the past year was 14.87 per cent in hay cut late in July. Dry thistles collected along the roadway in late fall contained 6.25 per cent of protein. The ash content of the Russian thistle is particularly high, running from 13 per cent to as high as 30 per cent (2) with one-half or more of the ash consisting of potash and lime (3).

REVIEW ON LITERATURE

There appears to be no record in the literature of experimental trials having to do with digestibility of Russian thistles. Neither are there any data on the feeding value of the thistles when fed to dairy cows.

McCampbell (4) reported the results of a feeding trial conducted at the Fort Hays (Kansas) Branch Experiment Station in 1918-1919 where Russian thistle hay and alfalfa hay were used in maintenance rations for beef cattle. In this experiment approximately one-third of the dry matter of the ration consisted of hay and two-thirds of straw and silage. Under these conditions the thistle hay, which was of good quality, was the equal of alfalfa hay for beef cattle maintenance.

More extensive trials with thistles were conducted during 1934-1935 at the Fort Hays Station (5). It was concluded from these trials that ground Russian thistle hay alone is not a satisfactory wintering ration for stock cattle, but with the addition of 4 pounds of blackstrap molasses and 1 pound of cottonseed cake per head daily it makes an excellent wintering ration.

The thistle hay used in the Fort Hays trials was rather mature and varied in protein content from 5.13 per cent to 6.56 per cent.

At the Akron, Colorado, U. S. Field Station (6) in 1931-1932, Russian thistle hay was shown to have about the same feeding value as cane fodder for lamb feeding.

DIGESTION TRIAL

Experimental Methods. In the digestion trial conducted at the Kansas Station three dry cows were used, there being a representative each of the Ayrshire, Holstein, and Jersey breeds. The length of the trial was 25 days, divided into a 15-day preliminary period and a 10-day collection period. At first all the cows refused to eat the thistles so that it was necessary to use about 50 per cent alfalfa hay. The alfalfa was gradually reduced and none was fed after the fifth day of the trial. The hay used was cut in early August while still fairly green and was baled as soon as possible. A few of the bales showed a small amount of mold.

Approximately 1,000 pounds of ground Russian thistles were carefully mixed and sampled for analysis. From the remainder, 44 feeds for each cow were weighed into paper bags and sealed. The amount of thistles fed per day varied from 4,000 grams, fed to a 925-pound cow, to 7,000 grams,

fed to a 1,325-pound cow. The cows were weighed daily and it was interesting to note that these amounts of thistles maintained the cows at a remarkably constant weight. Two of the cows consumed all feed offered but one cow refused a small amount of dusty material for several feeds. The total of this refusal was 1,498 grams of dry matter.

During the collection period the feces from each cow were secured and stored in tight covered cans. At approximately 24-hour intervals this was weighed, thoroughly mixed and a $\frac{1}{10}$ -aliquot sample taken. These daily aliquots were composited in tight covered cans and preserved with a small amount of chloroform. At the end of the 10-day collection period the composite samples were dried, ground and a uniform sample secured for analysis.

Results. The results of the digestion trial are contained in Table 1.

TABLE 1
Composition, digestibility, and digestible nutrients of Russian thistle hay

	DRY MATTER	CRUDE PROTEIN	ETHER EXTRACT	CRUDE FIBER	ASH	N FREE EXTRACT
Composition, per cent	86.22	9.25	0.96	22.50	15.65	37.86
Apparent digestibility, per cent	54.80	63.20	40.30	41.60		61.70
Digestible matter, lbs. per cwt.	47.25	5.85	0.39	10.04		23.36

The crude protein content of 9.25 per cent on the thistle hay used is high for a non-legume roughage but is much lower than that of alfalfa hay (7). The ash content of 15.65 per cent is higher than is found in most other roughages but the ether extract is very low. Most other samples of thistle hay on which analyses are reported, show a considerably higher fat content than did the hay used in this experiment. In crude fiber content the thistle hay used was lower than that of most dried roughages.

Although not as high as that of alfalfa the digestion coefficient of 63.2 for the protein of Russian thistle hay compares very favorably with that of most roughages. The digestibility of the crude fiber is approximately the same as that of alfalfa hay.

From the results of this digestion trial it appears that the Russian thistle hay used contained a total of 40.1 pounds of digestible nutrients per cwt. This was 80.5 per cent as much total digestible nutrients as that of the alfalfa hay used in the feeding trial.

MILK PRODUCTION TRIAL

Experimental Methods. In the milk production trial two lots of five cows each were fed by the double reversal method through three 30-day periods, the first ten days of each serving as a preliminary period. Each

lot contained one Guernsey, one Ayrshire and three Holstein cows and at the start of the experiment the average production per cow in each lot was approximately 35 pounds of milk daily. The sole roughage of the cows consisted either of ground alfalfa or ground Russian thistle hay.

Lot I was started on the thistle ration, and Lot II on the alfalfa ration. At the end of each 30-day period the rations furnished the lots were reversed. In addition to the hay, the cows while on thistles were fed a grain mixture of 2 parts ground corn, 1 part wheat bran, and 1 part choice cottonseed meal. Each cow also received 4 pounds daily of blackstrap molasses. This was added chiefly to increase the palatability of the thistles, although it also furnished considerable energy.

While on alfalfa hay the cows were fed a grain mixture of 4 parts ground corn and 1 part wheat bran. To each grain mixture was added 1 per cent of steamed bone meal and 1 per cent of salt. Each animal was fed according to her requirements as shown by the Morrison (8) standard.

Body weights were taken on three successive days at the beginning and end of each 20-day experimental period, the second of the three weight days falling on either the first or the last day of the period, as the case might be.

The milk from each cow was weighed and recorded at each milking. Samples were taken from the six milkings of each animal nearest the center of each 20-day experimental period and were tested for fat by the Babcock method. The average percentage of fat thus obtained was taken as the average for the period.

Samples of feeds for analysis were secured during each period. A sample of hay was composited from each lot ground, a sample of grain from each batch mixed, and a sample of molasses was secured from the container.

Results. The results of the milk production trial are given in Table 2.

TABLE 2
Summary of Lots I and II—(Pounds per cow per period)

	BODY WEIGHT			FEED CONSUMED			MILK AND FAT PRODUCED		
	Start	Finish	Change	Grain	Hay	Molasses	Milk	Fat	4% F.C.M.*
Alfalfa	1072	1071	-1	199.5	396.5		563.5	21.71	551.1
Thistles	1085	1089	+4	197.8	376.8	76.9	519.0	20.38	513.3
Increase			5						
Increase %			0.5						
Decrease				1.7	19.7		44.5	1.33	37.8
Decrease %				0.9	5.0		7.9	6.1	6.9

* F.C.M. = Fat corrected milk (.4M + 15F) Gaines, W. L. and Davidson, F. A. Relation Between Percentage Fat Content and Yield of Milk. Ill. Agr. Exp. Sta. Bul. 245.

The changes in body weight on the two rations were slight, there being a 1-pound loss per cow per period on the alfalfa rations as compared with

a 4-pound gain per cow on the thistle ration. In the consumption of feed the chief difference was in the molasses fed, as the cows on thistles received molasses while the cows on alfalfa received none. There was also a somewhat greater consumption of alfalfa hay than of thistle hay. However, this was not unexpected as an attempt was made to secure as much of the nutrients as possible from the hay portions of the ration and there was somewhat more refusal of thistle hay than of alfalfa.

The milk and fat production was rather consistently in favor of the alfalfa ration. The production of 4 per cent fat-corrected milk was 6.9 per cent less on the thistle ration than on the alfalfa ration.

Table 3 furnishes some information on the digestible nutrients consumed from the two rations.

TABLE 3

Nutrients consumed per cow per period and the percentage of the total furnished by the different ingredients of the ration

	ALFALFA RATION				THISTLE RATION			
	Dig protein	% of total	T. D. N.*	% of total	Dig protein	% of total	T. D. N.	% of total
	(lbs.)		(lbs.)		(lbs.)		(lbs.)	
Grain mix	16.4	27.9	153.4	43.7	28.3	55.5	145.7	42.5
Thistle hay					21.9	42.9	151.1	44.1
Alfalfa hay	42.4	72.1	197.4	56.3				
Molasses					0.8	1.6	45.8	13.4
Total	58.8	100.0	350.8	100.0	51.0	100.0	342.6	100.0

* T. D. N. = Total digestible nutrients.

From Table 3 it is apparent that the alfalfa hay was much more of a factor in the ration, from a protein standpoint, than was the thistles, since alfalfa furnished 72.1 per cent of the total protein of the ration while the thistles furnished only 42.9 per cent of the total.

Alfalfa hay furnished 56.3 per cent of the total digestible nutrients of the alfalfa ration, while the thistle hay furnished 44.1 per cent of the total of the thistle ration. Due to the fact that the Russian thistle hay used had only a little over one-half as much digestible protein as did the alfalfa hay it was necessary to make up this protein deficiency with cottonseed meal in the grain mixture. The total digestible nutrients consumed from the thistle ration was only 2.3 per cent less than the total digestible nutrients consumed from the alfalfa ration.

During some preliminary palatability trials and for a complete period during the course of the experiment, milk from the cows receiving thistle hay was examined daily for odor and flavor. Although slight feed flavors were noted at times, there was no consistent effect of the ration upon either the odor or the flavor of the milk produced.

Although a laxative action of Russian thistles is often mentioned by stockmen whose animals were receiving this feed, no such action was noted during this experiment either when the diet consisted wholly of thistles or where thistles furnished the roughage portion of the ration.

SUMMARY AND CONCLUSIONS

The Russian thistle hay used in these tests contained 62.1 per cent as much total protein, 55.2 per cent as much digestible protein, and 80.5 per cent as much total digestible nutrients as did the alfalfa hay used in the feeding trial.

Ground Russian thistle hay may be used with fairly satisfactory results to furnish 40 to 45 per cent of the protein and total digestible nutrients of a dairy cow's ration.

Alfalfa hay is a more satisfactory roughage for milk production than is Russian thistle hay. The thistle hay is much less palatable than is alfalfa hay and must be ground.

Russian thistle hay in the ration of dairy cows causes no appreciable off flavors or odors in the milk produced.

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American Dairy Science Association Announcements

ANNUAL MEETING, JUNE 16-19, 1936 STATE COLLEGE, PENNSYLVANIA

GENERAL INFORMATION

It is possible to announce at this time the general program for The American Dairy Science Association Meeting to be held the week of June 15 at The Pennsylvania State College. The College is preparing to entertain a large percentage of the members and their families. A detailed announcement and questionnaire concerning rooms will be sent to department heads about May 1. A program of entertainment for the wives, young people and children of members is being planned.

The members are reminded that titles of papers to be presented must be in the hands of S. I. Beechdel, Chairman of the Program Committee, by May 1st as per detailed announcement in the February issue of the Journal. Abstracts must be sent with titles by May 1st or very shortly thereafter if reprints of the abstracts are to be available for the members at the time of the meeting.

GENERAL PROGRAM

JUNE 15—MONDAY

- 1 P. M.—9 P. M. General registration and room registration, Dairy Building.

JUNE 16—TUESDAY

- 8 A. M.—9 P. M. General registration and room registration, Dairy Building.
9 A. M.—12 Noon Dairy Cattle Judging Conference.
12 Noon—1 P. M. Lunch hour.
1 P. M.—4 P. M. Extension Section Meeting.
1:30 P. M.—4:30 P. M. Dairy Products Judging Conference.
7:30 P. M. Opening session and Business Meeting, College Auditorium.
8:30 P. M. Social get-together for members and their families, 2nd floor lounge, Old Main Building.

JUNE 17—WEDNESDAY

- 8 A. M.—12 Noon General registration and room registration, Dairy Building.
9 A. M.—4 P. M. Complimentary mountain tour for wives, young folks and children of members. See the mountain laurel in bloom and visit Alexander Caverns. Lunch at Greenwood Forest Camp. Tickets at registration.

- 8 A. M.-9 A. M. Sectional Committee meetings.
 9 A. M.-12 Noon General Session, College Auditorium.
 12 Noon Complimentary Dairy Lunch, Dairy Building.
 1 P. M.-4 P. M. Sectional Scientific meetings.
 4 P. M.-4:30 P. M. Sectional Committee meetings.
 4 P. M.-5 P. M. See places of interest on College Campus. Respiration calorimeter, Jordan Fertilizer plots (oldest in America), mineral industries exhibit.
 6:30 P. M. Creamery Package Mfg. Company—Complimentary dinner for members and their wives. McAllister Hall. Tickets at registration.

JUNE 18—THURSDAY

- 8 A. M.-9 A. M. Extension Exhibit.
 9 A. M.-12 Noon Sectional Scientific meetings.
 9 A. M.-12 Noon Children and young folks program—Supervised play, municipal playground, or mountain hike for those who prefer it.
 10 A. M. For Ladies—Places of interest on the Campus. Old Main Tower, Home Economics building, Mineral Industries exhibits, Rose gardens adjacent dairy buildings. Golf for those who prefer it.
 12 Noon-1 P. M. Lunch hour.
 1 P. M.-2 P. M. Sectional Business Meetings.
 2 P. M.-4:30 P. M. Scientific meetings—Extension, Manufacturing and Instruction sections.
 2 P. M.-4 P. M. Children and young folks program—Swimming at the Glennland Pool, finest in Pennsylvania. Admission by complimentary ticket. Exclusive use of pool reserved.
 2 P. M.-4 P. M. Entertainment for ladies at the Nittany Lion Inn.
 6:30 P. M. Subscription Banquet, McAllister Hall. (Tickets to be purchased at registration.)

JUNE 19—FRIDAY

- 8 A. M.-9 A. M. General Business session.
 9 A. M.-12 Noon Scientific meetings—Manufacturing and Production sections.
 12 Noon-1:30 P. M. Lunch hour.
 2 P. M. Optional tours,—Kylertown pasture fertilizer project, Kylertown, Pa., Fisherman's Paradise, Pleasant Gap, Pa., U. S. Dairy Bureau farm, Beltsville, Md.

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VITAMIN D STUDIES IN CATTLE. III. INFLUENCE OF SOLAR ULTRAVIOLET RADIATION UPON THE BLOOD CHEMISTRY AND MINERAL METABOLISM OF DAIRY CALVES*

C. W. DUNCAN AND C. F. HUFFMAN

Section of Chemistry and Section of Dairy Husbandry, Michigan Agricultural Experiment Station, East Lansing

There seems to be fairly general agreement among investigators at the present time that young, growing dairy calves require and utilize vitamin D and/or radiant energy but definite information on the influence of solar ultraviolet radiation upon the blood chemistry and mineral metabolism of these animals is not available. Raczynski (1), however, produced the first evidence of the therapeutic value of radiant energy when he subjected the bodies of two young puppies of the same litter and nursed by their mother, to chemical analysis. One puppy had been kept in the sunlight for six weeks and the other one had been deprived of sunlight for the same period. The body of the first puppy contained much more calcium and phosphorus than did that of the second puppy. He concluded from this experiment that the lack of sunlight was one of the causes of rickets.

Some investigators (2-4) have reported that calves do not require or utilize the radiant energy from the sun since calves which were grown in the dark and fed ordinary rations apparently did just as well as calves which had access to sunshine. In a progress report by Bechdel, Dutcher and Tucker (5), it was indicated that vitamin D therapy was just as applicable to the bovine as to other species of animals. Hill (6) has demonstrated the beneficial influence of direct irradiation of calves with a carbon-arc lamp and the protection against rickets which cod liver oil afforded.

Huffman (7) has shown that calves which had received rations low in vitamin D and kept out of contact with sunshine developed rickets while calves on the same basal ration turned outside to sunshine or had their rations supplemented with cod liver oil did not manifest the symptoms of rickets. Other investigators have confirmed and amplified the above findings (8-11). Rosenkranz (12) has described changes in the thyroids of young cattle. Cattle which were kept in stalls out of contact with sunshine

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exhibited a marked increase in parenchyma with a diminished number of follicles and colloidal content while cattle out on pasture, getting plenty of sunshine, had normal thyroids, well filled follicles and little parenchyma.

The purpose of this investigation was to study the relationship of solar ultraviolet radiation to the prevention and cure of rickets in order to obtain more fundamental information in regard to the role of vitamin D in the nutrition of the dairy calf.

EXPERIMENTAL

Eight healthy grade Holstein calves were used in this experiment, three being males and five females. From birth to about 30 days of age the calves received whole milk twice daily in amounts according to the needs of each calf, after which time the whole milk was replaced by skim milk and a mixture of corn and oats. The mixture of corn and oats was replaced at about 90 days of age by the rachitogenic grain mixture, the composition of which has been previously reported (10-11). The skim milk was discontinued at about 120 days of age.

In addition to this ration, C-97 received 10 cc. of cod liver oil per day and alfalfa hay ad lib. from the 14th to the 74th day of age. C-106 received timothy hay ad lib. from the 183rd to the 263rd day of age.

Calves C-118, C-151 and C-167 were fed the rachitogenic grain mixture and kept out of doors during the day to determine the efficacy of the ultraviolet rays from the sun in the prevention of rickets. C-118 was also exposed to the rays of a carbon-arc lamp for 5 minutes per day from December 10, 1931 to January 19, 1932 and for 10 minutes per day from February 28 to March 29, 1932. Calves C-97, C-106 and C-117 were used to determine the curative value of solar ultraviolet radiation after the onset of rickets. Calves C-111 and C-116 were used to determine the length of time required to deplete the calves of their vitamin D storage after having spent the spring and early summer months out of doors.

The calves which were kept indoors during the day were turned into a bare lot at night for exercise. They were offered water twice daily. Shavings were used for bedding. The calves were weighed every 10 days and measured for height at withers once a month.

Blood samples were obtained every 2 weeks, in many cases every week, from the jugular vein of each of the experimental calves and the plasmas were analyzed for calcium, inorganic phosphorus (13) and magnesium (14) by methods which have been recorded. The values which are given in the tables are the mean concentrations for the respective periods. The 8th rib on the right side, a section of the orbital plate and the right dental pad were used for the determination of ash, calcium, phosphorus and magnesium by methods which have also been recorded (10). The feces and urine, which were collected separately by means of pails and shovels by attendants, were

weighed or measured at the end of each 24-hour period. The excreta and feed samples were composited for each experimental period and aliquot samples of each were taken for chemical analysis. The methods of analysis were the same as in previous work (15).

RESULTS

Antirachitic Value of Solar Ultraviolet Radiation to Calves

In order to determine the protective action of solar ultraviolet rays, three calves were fed the rachitogenic ration and allowed to exercise in a bare lot during the day. The amounts of direct solar radiation which they received varied from day to day depending upon weather conditions.

Calf C-118. This calf was born February 19, 1931, and was turned outside for the first time February 26, 1931. A blood sample taken from this calf at 15 days of age gave normal values. Blood samples were secured at weekly intervals until the calf was changed to the rachitogenic ration at about 90 days of age and at two-week intervals thereafter. Table 1 presents the experimental data secured from this calf and shows a typical example of the protection against rickets afforded by exposure to solar ultraviolet radiation as revealed by the blood plasma data. It is also of interest to note the seasonal variations in the plasma calcium and inorganic phosphorus values. The calcium shows a tendency to drop during January and then increase to a maximum in April. The decline in the inorganic phosphorus and magnesium during January, February and March was more pronounced even though the calf had been exposed to the rays of a carbon-arc lamp during parts of these months. C-118 was removed from this phase of the experiment in May, 1932.

Calf C-151. This calf was bled at 15 days of age and every 2 weeks thereafter. As shown in Table 1, the blood data do not indicate rickets. This calf was normal in every respect when slaughtered at 194 days of age. The results of the analysis of some of the bones appear in Table 5.

Calf C-167. This calf was turned outside in a dry lot daily as soon as good practice would permit. The calf was bled at 2 days of age and every two weeks thereafter. Table 1 presents the monthly composite values for the duration of the experiment. These values do not reveal any indications of a rachitic nature. The calf was normal in every respect when removed from the experiment at 191 days of age. The blood values indicate, however, a seasonal decline due to the decrease in the intensity of the solar ultraviolet rays.

Curative Value of Solar Ultraviolet Radiation After the Onset of Rickets

Calf C-97. This calf was first bled at 140 days of age at which time the plasma calcium and inorganic phosphorus values were normal. The next blood sample was secured when the calf was 190 days of age. By this time

TABLE 1
Data pertaining to calves which received the rachitogenic ration supplemented with solar ultraviolet radiation

CALF	DATE	AGE	WEIGHT	AV. DAILY INTAKE			PLASMA		
				Ca	P	Mg	Ca	P	Mg
no.		mo.	lb.	gm.	gm.	gm.	mg. per 100 cc.		
C-118	3-21-31	1	96	4.7	3.7	0.5	11.0	6.68	1.81
	4-20	2	129	6.3	5.8	0.9	11.2	7.35	1.29
	5-20	3	167	7.6	8.1	1.7	11.5	7.58	1.66
	6-19	4	208	13.3	9.8	3.1	12.1	7.60	2.61
	7-19	5	238	12.9	8.9	3.8	12.5	7.40	1.76
	8-18	6	269	12.8	8.1	4.5	11.2	7.69	2.88
	9-17	7	313	14.7	9.4	5.2	11.9	8.61	2.50
	10-17	8	354	16.4	10.7	5.9	11.9	8.61	2.36
	11-16	9	407	16.5	10.7	5.9	11.7	8.78	2.94
	12-16	10	438	16.6	10.7	6.0	11.8	8.40	2.99
	1-15-32	11	476	17.7	12.3	6.4	11.4	8.61	2.30
	2-14	12	524	20.8	13.1	7.5	11.8	8.60	2.26
	3-15	13	557	21.0	13.7	7.6	13.7	6.72	2.35
	4-14	14	579	20.9	13.9	7.5	13.9	8.05	2.79
	5-14 ¹	15	637	21.0	14.1	7.5	13.5	8.78	2.60
C-151	4-3-32	1	105	6.3	5.0	0.6	12.3	6.40	2.33
	5-3	2	123	8.2	6.6	0.9	13.5	6.91	2.09
	6-2	3	163	11.4	8.7	2.0	13.6	7.80	2.22
	7-2	4	214	14.4	10.8	3.1	14.7	7.81	2.76
	8-1	5	252	13.7	8.8	4.7	14.1	7.53	3.47
	8-31	6	257	11.6	6.9	4.2	12.9	7.20	2.39
	9-14 ²	7	288	11.7	6.8	4.2	13.1	7.84	2.52
C-167	5-25-32	1	104	5.6	4.2	0.5	13.1	6.41	2.48
	6-24	2	136	9.1	7.9	1.4	14.7	7.40	2.55
	7-24	3	176	10.4	10.8	2.7	14.8	8.65	2.42
	8-23	4	206	15.1	11.7	3.4	13.6	8.48	1.87
	9-22	5	239	10.3	7.1	3.8	12.4	7.18	1.98
	10-22	6	262	11.0	7.5	4.4	11.8	8.42	2.47
	11-2 ³	7	280	13.8	9.3	5.3	11.3	6.58	1.74

¹ Removed from experiment.

² Slaughtered at 194 days of age, no evidence of rickets.

³ Changed to another experiment at 191 days of age.

the calcium had declined to 6.6 mg. per 100 cc. of plasma but the inorganic phosphorus remained within the normal range. When the calf was turned outside on March 5, the plasma calcium and inorganic phosphorus values were 7.6 and 5.90 mg. The rachitic condition became worse and the calf continued to show signs of stiffness and irritability although it had received some radiant energy. No improvement was noticed in the condition of the calf until it had been outside for about 42 days. By this time the intensity of the ultraviolet radiation had increased sufficiently to cause a reversal in the downward trend of the blood constituents. The rachitic symptoms were completely alleviated by May 15, when the calcium and inorganic phosphorus increased to 11.6 and 8.74 mg., respectively. Table 2 shows the cessation of growth from January to April during which time the calf was suffering from

TABLE 2

Data pertaining to calves whose rachitogenic rations were supplemented with solar ultra-violet radiation after the onset of rickets

CALF	DATE	AGE	WEIGHT	AV. DAILY INTAKE			PLASMA		
				Ca	P	Mg	Ca	P	Mg
<i>no.</i>		<i>mo.</i>	<i>lb.</i>	<i>gm.</i>	<i>gm.</i>	<i>gm.</i>	<i>mg. per 100 cc.</i>		
C-97	8-13-30	1	85	5.9	4.5	0.7			
	9-12	2	115	7.5	5.7	1.1			
	10-12	3	155	9.7	7.7	2.1			
	11-11	4	207	11.7	9.8	3.0			
	12-11	5	241	11.1	7.7	3.9	11.3	7.35	1.09
	1-10-31	6	292	13.0	9.0	5.0	6.6	7.08	
	2-9 ¹	7	296	13.2	9.1	5.1	7.0	7.19	
	3-11 ²	8	292	14.0	8.1	4.4	7.4	5.92	1.51
	4-10	9	299	11.0	7.6	4.3	8.8	5.70	2.01
	5-10 ³	10	339	13.3	9.2	5.1	12.1	8.11	1.47
	6-9	11	390	15.3	10.7	5.9	11.8	7.66	1.85
	7-9	12	430	16.4	11.4	6.3	11.1	7.54	2.57
	8-8	13	454	17.5	12.2	6.7	12.4	7.34	3.21
	9-7	14	491	17.5	12.2	6.7	13.5	7.26	3.41
	10-7 ⁴	15	526	17.5	12.2	6.7	11.5	8.27	2.85
C-106	12-2-30	1	123	6.1	4.8	0.5			
	1-1-31	2	158	6.9	6.7	1.5	5.6	7.23	
	1-31 ⁵	3	186	7.8	7.2	1.9	6.5	7.02	1.94
	3-2	4	207	12.6	9.4	3.3	5.8	7.46	
	4-1 ⁶	5	211	8.9	6.2	3.4	6.9	5.34	1.60
	5-1	6	214	9.5	6.6	3.6	7.4	5.29	2.07
	5-31	7	209	9.3	5.9	3.5	7.7	4.66	1.95
	6-30	8	207	8.7	5.5	3.2	7.8	4.14	1.65
	7-28 ⁷	9	198	12.6	5.7	4.0	8.0	3.44	2.82
	8-29	10	201	8.8	5.8	3.2	11.3	3.75	3.18
	9-28	11	223	11.2	7.5	4.1	11.8	6.54	3.43
	10-28 ⁸	12	266	13.6	9.3	5.1	11.3	6.52	2.17
	11-27	13	304	14.4	9.9	5.4	10.9	6.30	2.42
	12-27	14	345	16.0	11.0	6.0	11.2	6.57	2.31
	1-26-32 ⁹	15	392	17.7	12.2	6.7	11.5	6.16	2.14
C-117	12-30-30	1	86	4.5	3.6	0.5			
	1-29-31	2	123	6.3	5.8	1.0			
	2-28 ¹⁰	3	145	7.0	7.3	1.4	9.4	6.20	0.99
	3-30 ¹¹	4	179	11.9	9.1	2.8	6.3	6.98	1.26
	4-29	5	208	10.0	6.7	3.4	11.2	7.62	1.85
	5-29	6	257	12.7	8.5	4.6	11.4	8.00	1.87
	6-8 ¹²	7	272	13.7	9.1	4.9	10.9	7.23	1.64

¹ Stiffness first observed 2-11-31.

² Turned outside into sunshine after 3-5-31.

³ No evidence of rickets 5-19-31.

⁴ Changed to another experiment.

⁵ Tetanic convulsion 1-26-31.

⁶ Legs badly bowed 4-15-31.

⁷ Turned outside into sunshine after 7-27-31.

⁸ No evidence of rickets 10-2-31.

⁹ Changed to another experiment 1-26-32.

¹⁰ Tetanic convulsion when turned outside 2-27-31.

¹¹ Stiffness and irritability 3-20-31.

¹² No evidence of rickets when slaughtered 6-8-31.

active rickets. The table also shows a tendency toward a seasonal variation in the plasma calcium and inorganic phosphorus. The calf was removed from this phase of the experiment on October 7, 1931. Table 5 presents the ash and percentage composition of some of the bones at the time of slaughter.

C-106. When this calf was first bled at 30 days of age the calcium and inorganic phosphorus values were 5.6 and 7.23 mg. per 100 cc. of plasma.

TABLE 3

Data pertaining to calves whose rachitogenic ration had been supplemented with solar ultraviolet radiation for 5 months and then deprived of this energy

CALF	DATE	AGE	WEIGHT	AV. DAILY INTAKE			PLASMA		
				Ca	P	Mg	Ca	P	Mg
<i>no.</i>		<i>mo.</i>	<i>lb.</i>	<i>gm.</i>	<i>gm.</i>	<i>gm.</i>	<i>mg. per 100 cc.</i>		
C-111	12-12-30	1	113	4.8	3.9	0.6			
	1-11-31	2	113	4.3	3.5	0.5			
	2-10	3	139	5.8	5.1	0.8	8.8	6.50	
	3-12	4	167	10.4	7.8	2.6	7.6	5.19	2.09
	4-11	5	191	8.4	5.5	3.0	7.2	7.40	1.58
	5-11	6	223	10.7	7.0	3.8	11.3	7.48	2.24
	6-10	7	244	11.7	7.7	4.3	11.0	7.94	2.70
	7-10	8	288	13.2	8.7	4.7	11.2	7.25	2.88
	8-9 ¹	9	309	13.9	9.1	5.0	11.8	7.41	3.04
	9-8	10	367	14.0	9.1	5.0	11.7	8.58	3.16
	10-8	11	412	15.5	10.1	5.6	10.9	8.42	3.15
	11-7 ²	12	432	15.6	9.2	5.1	10.0	6.92	3.14
	12-7	13	458	15.4	9.1	5.0	9.1	6.72	2.65
	1-6-32 ³	14	460	13.8	9.1	4.9	8.2	5.90	2.17
	2-5	15	460	15.3	10.1	5.5	9.2	4.16	2.13
	2-29 ⁴ - ⁵	16	443	11.2	7.5	4.0	8.2	4.81	2.82
C-116	12-29-30	1	114	5.9	4.3	0.6			
	1-28-31	2	124	6.7	5.8	0.8			
	2-27	3	131	7.6	6.6	1.2	9.1	6.79	2.06
	3-29	4	164	11.7	8.7	2.6	9.1	5.70	1.57
	4-28	5	164	6.8	4.4	1.9	8.4	5.57	1.55
	5-28	6	216	11.5	7.3	4.0	10.5	6.66	2.06
	6-27	7	254	15.5	8.9	4.9	11.0	7.55	2.50
	7-27 ¹	8	276	14.3	9.1	5.1	12.1	7.47	2.46
	8-26	9	324	14.8	9.1	5.2	11.8	7.02	3.31
	9-25	10	349	14.7	9.1	5.2	10.4	7.55	3.61
	10-25	11	352	14.8	9.1	5.2	9.1	7.62	2.70
	11-24	12	364	14.6	9.1	5.2	8.3	5.48	2.63
	12-24 ⁶	13	368	14.0	9.1	5.0	7.5	6.07	1.70
	1-23-32	14	375	14.2	9.3	5.1	7.3	5.12	1.84
	2-22	15	364	14.2	9.3	5.1	7.9	3.40	1.99
	3-15 ⁷ - ⁸	16		8.5	5.6		9.4	2.97	2.26

¹ Sunshine discontinued 7-16-31.

² Tetanic convulsions 10-24-31.

³ Stiffness first observed 1-10-32.

⁴ Fractured vertebra 2-25-32.

⁵ Coma, slaughtered 2-29-32.

⁶ Stiffness first observed 12-27-31.

⁷ Tetanic convulsion 3-1-32.

⁸ Fractured pelvis 3-9-32.

⁹ Died 3-15-32.

During the next seven months the calcium values increased slowly to a maximum of 8.6 mg. while the inorganic phosphorus values progressively decreased to a minimum of 1.95 mg. when the calf was turned outside to brilliant sunshine in July. The rachitic condition was severe, the joints had become enlarged and the calf could stand only with difficulty. The change from the deprivation of sunshine to brilliant sunshine caused an immediate and considerable increase in the plasma calcium but failed to cause the inorganic phosphorus to return to normal until the middle of September. The rachitic condition was completely alleviated by October and the calf did not show any indication of rickets when removed from the experiment in January, 1932. Table 2 shows the lack of growth and loss of weight during the time that the rachitic conditions was most severe. The analyses of some of the bones of C-106 are presented in Table 5.

Calf C-117. The calcium and inorganic phosphorus values for this calf at 58 days of age were 9.6 and 6.13 mg. per 100 cc. of plasma. It was turned

TABLE 4
Metabolism data secured from two calves which received the rachitogenic ration supplemented with sunshine and then deprived of sunshine

CALF	AV. DAILY INTAKE	AV. DAILY OUTGO			BALANCE	STORED	PLASMA		
		Urine	Feces	Total			Ca	P	Mg
<i>no.</i>	<i>gm.</i>	<i>gm.</i>	<i>gm.</i>	<i>gm.</i>	<i>gm.</i>	<i>%</i>	<i>mg. per 100 cc.</i>		
C-111 ¹	Ca 15.10	1.31	5.50	6.81	8.29	54.9	11.6	8.16	2.50
	P 10.24	2.00	3.00	5.00	5.24	51.2			
7/9/31	Mg 4.18	1.00	4.33	5.33	-1.15				
	N 83.20	43.62	14.43	58.05	25.15	30.2			
C-116 ²	Ca 15.44	0.55	6.86	7.41	8.03	52.0	12.0	7.39	1.81
	P 10.25	1.44	2.71	4.15	6.10	59.5			
7/9/31	Mg 4.22	1.00	3.81	4.81	-0.59				
	N 83.24	43.70	17.16	60.86	22.38	26.9			
Calves deprived of sunshine									
C-111 ³	Ca 12.60	0.08	13.49	13.57	-0.97		11.6	7.38	4.15
	P 7.46	2.23	9.07	11.30	-3.84				
10/21/31	Mg 4.51	0.54	4.08	4.62	-0.10				
	N 87.55	28.96	22.46	51.42	36.12	41.3			
C-116 ³	Ca 13.09	0.24	10.92	11.16	1.93	14.7	8.9	4.78	3.83
	P 7.45	4.63	4.34	8.97	-1.52				
10/28/31	Mg 4.51	1.20	3.78	4.98	-0.47				
	N 87.55	61.99	12.45	74.44	13.11	15.0			

¹ Developed rickets during Jan. 1931, turned outside Feb. 1, 1931, no evidence of rickets and blood picture normal by May 1, 1931.

² Developed rickets during Jan. 1931, turned outside Feb. 1, 1931, no evidence of rickets and blood picture normal by June 1, 1931.

³ Sunshine discontinued July 17, 1931.

outside February 27, 1931 to receive advantage of the winter sunshine. The limited amount of sunshine which it received during February and March was insufficient to maintain the plasma calcium within the normal range but it did maintain the inorganic phosphorus. C-117 had a tetanic convulsion at 90 days of age and manifested mild rickets at 100 days of age. The calf was slaughtered at 190 days of age but no evidence of rickets was observed at that time. The age, weight, the average daily mineral intake and the blood picture are presented in Table 2. The bone data are shown in Table 5.

TABLE 5
Ash and mineral content of bones from the experimental calves

CALF	BONE	AGE	WEIGHT	ASH	Ca	P	Mg	TERMINAL PLASMA		
								Ca	P	Mg
no.		days	lb.	%	%	%	%	mg. per 100 cc.		
C-97	8th	844	645	59.25	23.49	10.06	1.20	9.2	7.06	1.79
C-106	right	1002	662	57.35	22.60	9.91	0.51	10.1	4.46	2.60
C-111	rib	474	425	49.02	19.66	8.80	0.75	8.0	4.00	3.45
C-116		472	317	44.15	17.38	7.66	0.53	8.1	3.51	2.33
C-117		190	272	53.80	19.60	10.15	0.43	10.9	7.23	1.64
C-151		194	288	50.80	19.29	9.01	0.73	13.8	7.44	2.58
C-97	Orbital			54.05	20.19	10.17	1.43			
C-106	plate			59.55	23.22	9.86	1.20			
C-111				50.97						
C-116				50.00						
C-117				53.57						
C-151				51.75	20.18	9.51	1.18			
C-97	Dental			59.85	23.75	10.67	0.85			
C-111	pad			47.29						
C-116				44.15						
C-117				56.68						
C-151				57.30	22.21	10.62	0.64			

Duration of the Reserve of Vitamin D in the Calf's Body After Being Deprived of Solar Ultraviolet Radiation

Calf C-111. This calf was first turned outside to winter sunshine at 80 days of age. The calcium and inorganic phosphorus values were 8.5 and 6.51 mg. per 100 cc. of plasma at this time. The intensity of the solar ultraviolet rays during February and March was insufficient to maintain the calcium and inorganic phosphorus within normal limits. Evidences of rickets or irritability were not observed in this calf. The plasma calcium and inorganic phosphorus returned to normal during April and remained within the normal range until after the metabolism trial in July.

In order to secure a better idea of how efficiently this calf was utilizing

its feed after constant exposure to spring and summer sunshine, a 7-day metabolism trial was run. The results, tabulated in Table 4, show that the calf was storing 54.9 per cent of the calcium and 51.3 per cent of the phosphorus contained in the feed.

After the completion of the metabolism trial, the calf was continued on the same ration but was deprived of sunshine. The results, presented in Table 3, show that the deprivation of solar radiation caused the plasma calcium values to decline steadily but the inorganic phosphorus increased temporarily before it progressively declined to the termination of the experiment.

On October 21st, 106 days after C-111 had been deprived of sunshine, the second 7-day metabolism trial was started. The results, recorded in Table 4, now show that the calf was losing calcium and phosphorus from its body. The plasma calcium and inorganic phosphorus values during this period (11.6 and 7.38 mg.) do not indicate the severe drain which was taking place but by the following week these values had dropped to 9.4 and 6.41 mg., respectively. The effect of the rachitogenic ration upon the blood picture of C-111 did not begin to appear until the week following the metabolism trial when the plasma calcium began to fluctuate widely and the inorganic phosphorus steadily declined. C-111 became extremely rachitic by February, 1932. On February 25 a vertebra became fractured and the animal was slaughtered. The ash values are presented in Table 5.

Calf C-116. This calf was first bled at 60 days of age when it was turned outside to winter sunshine. The calcium and inorganic phosphorus values were 8.8 and 7.23 mg. per 100 cc. of plasma. The blood picture of this calf was similar to that of C-111 because the intensity of the solar ultraviolet rays was insufficient to keep the concentrations of plasma calcium and inorganic phosphorus up to normal. These elements did not regain their normal values until late in May but evidences of rickets were not observed. By the time of the metabolism trial in July the concentrations of plasma calcium and inorganic phosphorus were 12.0 and 7.39 mg. The metabolism trial lasted for 7 days as in the case of C-111. The results of the trial show that C-116 was storing 52.0 per cent of the calcium in the feed and 59.5 per cent of the phosphorus as a result of the therapeutic effects of the radiant energy.

After the completion of this trial C-116 was deprived of the benefit of sunshine. An examination of Table 3 shows that there was a progressive and considerable decrease in the concentration of plasma calcium, a temporary increase in the concentration of inorganic phosphorus and then a precipitous drop in the phosphorus which continued to the fatal termination of the experiment.

On October 28th, 113 days after C-116 had been deprived of sunshine, a second 9-day metabolism trial was started. The results of this trial show

that the calf was storing a small percentage of the calcium in the feed but that the phosphorus balance was negative. The concentrations of plasma calcium and inorganic phosphorus at this time would also indicate this condition. The effect of the rachitogenic ration upon the blood picture of C-116 was observable for 6 weeks previous to the trial. The plasma calcium fluctuated widely but significant changes in the inorganic phosphorus did not occur until the week of the trial when the phosphorus abruptly dropped from 7.76 to 4.38 mg.

C-116 became extremely rachitic following the metabolism trial and was slaughtered in March, 1932, after the pelvis had become fractured. The data secured from the metabolism trial are presented in Table 4 and the bone data in Table 5.

DISCUSSION

The basal rachitic ration plus daily exposures to solar ultraviolet radiation produced normal growth and development in calf C-118 from birth to 15 months of age and from birth to 7 months of age in calves C-151 and C-167. An examination of the plasma calcium values of these calves reveals the tendency of a seasonal increase in calcium during the early summer months (May, June and July, depending upon the amount and intensity of solar ultraviolet rays) and the corresponding decline during the early winter months (November, December and January). The inorganic phosphorus values show a stronger tendency to increase to a maximum during July and August and then decrease to a minimum during January and February. Neither the physical condition nor the blood values indicated any evidence of rickets in these calves.

The three calves which received the rachitogenic ration (C-97, C-106 and C-117) and were deprived of solar radiation, manifested all of the outward symptoms of rickets within 30 to 90 days after receiving the rachitogenic ration. C-97 did not manifest rickets as soon as C-106 and C-117 because this calf had received 10 cc. of cod liver oil per day and alfalfa hay ad lib. from the 14th to the 74th day of age. The vitamin D reserve was soon depleted, however, after the change to the rachitogenic ration. Anorexia became pronounced, growth ceased and stiffness was evident. Calf C-106 had a convulsion at 85 days of age but the first evidence of rickets, as indicated by stiffness, was at 163 days of age. Timothy hay was offered to the calf at 173 days of age but due to anorexia, she consumed less than 1 pound of hay per day for the next 90 days. This amount of hay was insufficient to afford protection against rickets. C-117 was rachitic when turned outside to March sunshine at 100 days of age.

C-97 and C-117 were completely cured of rickets within 45 days after being exposed to April and May sunshine. It required about 60 days exposure to August and September sunshine to alleviate the rachitic condition

in C-106. The plasma calcium and inorganic phosphorus values of the calves increased to normal within 30 days after the calves were turned outside, with the exception of the inorganic phosphorus of C-106 which required about 60 days.

The concentration of plasma calcium was below normal in both C-111 and C-116 when they were first turned outside in January. The intensity of the ultraviolet rays in the February and March sunshine was insufficient to raise the calcium concentration to normal. The metabolism trials in July demonstrate the antirachitic potency of early summer sunshine. The metabolism data in Table 4 show how efficiently these calves were utilizing the calcium, phosphorus and nitrogen in the ration when they had access to sunshine. The metabolism data of these same calves after being deprived of sunshine for approximately 3 months present a different picture. In both cases there was a reduced or negative balance of calcium and phosphorus due to the defective utilization of these elements and also to a demineralization of the bones. These data also show a shift of calcium from the urine to the feces. There was a marked decrease in the actual amount of calcium excreted through the urine while there was an increase in the actual amount of phosphorus excreted through both the urine and feces. These data indicate that one important defect in rickets lies in the inadequate retention and utilization of calcium and phosphorus.

Under the conditions of this experiment the Ca:P ratio was the same for each calf after being placed on the rachitogenic ration, therefore the limiting factor was the presence or absence of radiant energy. The Ca:P ratio was Ca:P::1:1.5. The ratio of the retention and total excretion of calcium and phosphorus of C-111 and C-116 during the first trial approached the ratio of these elements in the ration. During the second trial the ratio of the total excretion was Ca:P::1:1.22 which indicates that the rate of excretion of phosphorus is greater than calcium during the period of active rickets.

The severity of the rachitic condition of C-111 was not as pronounced as in C-116, probably due to the establishment of a larger reserve of calcium, phosphorus and vitamin D. This condition was temporarily associated with the normal concentration of inorganic phosphorus in the plasma although the concentration of calcium and the rate of growth had decreased. In this case the occasional analysis of the blood would not have given reliable information as to the progress of the rachitic condition but when the blood was analyzed every week the progress of the rachitic condition could be followed with some degree of reliability. The nitrogen metabolism apparently had not been disturbed in C-111, whereas C-116 was undergoing a severe metabolic change. This condition is indicated when the rates of growth of C-111 and C-116 between the two trials are compared. C-111 gained 133 pounds while C-116 gained only 72 pounds.

A characteristic symptom of rickets is the disturbance of the calcium

and phosphorus metabolism which results in imperfect calcification of the growing bones. In extreme rickets some of the calf bones become soft, the joints enlarged, the calf becomes stiff and abnormal locomotion results. The results from the bone data indicate a significant difference between the rachitic and non-rachitic bones. Total ash content and the percentages of calcium, phosphorus and magnesium have been included for the 8th right rib, a section of the orbital plate and the right dental pad. The long bones were also subjected to analysis but the results are not included. The insignificant differences in the ash content of the long bones indicate that changes in the mineral content of these bones tend to take place very slowly even when the calf is suffering from active rickets. After comparing the normal values with the results obtained from the analyses of these bones and other bones in more severely rachitic calves, it was decided to omit future analyses of all except the rib bones. By analyzing definite lengths or zones of the rib, the shift in calcium and phosphorus from the bone to the blood can be followed to better advantage. This method of studying some of the chemical components of rachitic and normal ribs will be reported in a subsequent paper.

It was not the purpose of this report to postulate on the mechanism of vitamin D action but to show the essentiality of radiant energy in the dietary régime of the dairy calf. One observation seems pertinent, however, all of the rachitic calves had a large accumulation of bile in the gall bladder at autopsy. The color and viscosity were also abnormal. Variations in color from brick-red to yellow were noted, while the viscosity was analogous to firm egg-white. This pathological observation may have some significance when viewed in the light of recent reports by Greaves and Schmidt (16) (17) who demonstrated the rôle of bile in the transport of vitamin D across the intestinal wall.

SUMMARY

1. Young calves are susceptible to rickets when solar ultraviolet radiation or some form of vitamin D is lacking in their dietary régime.

2. When the concentrations of calcium and inorganic phosphorus in the plasma are determined at weekly intervals, the progressive downward trend of either or both of these constituents usually preceded all other outward evidence.

3. The deficiency of radiant energy was also manifested by anorexia, by cessation of, or decrease in the rate of growth, stiffness and bowing of the forelegs and finally, by the reduction of the ash and mineral content of the moisture-free, fat-free rib.

4. The exposure of rachitic calves to early spring sunshine caused the concentrations of calcium and inorganic phosphorus in the plasma to increase markedly. There was also a significant increase of these constituents in normal calves during the summer months and a corresponding decrease during the winter months.

5. These experiments demonstrate the effectiveness of solar ultraviolet radiation in enabling or permitting the calf to utilize more economically the materials present in the ration but not available to the body without the benefit of radiant energy or a supplementary form of vitamin D.

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EFFECTS OF TIME AND TEMPERATURE OF HOLDING MILK HEAT-TREATED AT VARIOUS TEMPERATURES UPON ITS SUBSEQUENT COAGULATION BY RENNET*

MILTON E. POWELL

Division of Agricultural Biochemistry, University of Minnesota, St. Paul

The author (1) has shown that artificial "milks" composed of a calcium caseinate-colloidal calcium phosphate sol exhibit a hysteresis-like effect when heat-treated and coagulated with rennet at various intervals after heating. This effect which results in a progressive loss of coagulability as the interval between heating and addition of rennet increases, has been shown by Mattick and Hallett (2) and Moir (3) to occur in natural milk. In order to obtain further data on this phenomenon in natural milk observations were made on the effects of the time and temperature of holding on the rennet coagulability of heat-treated skimmilks.

STUDIES WITH MILK PASTEURIZED BY THE HOLDING METHOD

During the entire study both the holding method and the flash pasteurization process were used. With the first method two liters of fresh skim milk were placed in a loosely stoppered flask and rapidly heated in a water bath to 65° C., 75° C. or 85° C. and maintained at the respective temperature for 30 minutes. A portion of each lot of milk was then kept at the heating temperature while two other portions were removed and rapidly cooled, one to 35° C. and the other to 5° C., each being held at that temperature. Two 50 ml. samples were immediately removed from that portion cooled to 35° C. and rennet added for coagulation. Duplicate 50 ml. samples from each of the above portions were removed and rennet added at various intervals after the initial heating period. All samples were coagulated at 35° C. in the electrically heated and controlled water bath previously (1) described. At least two complete determinations were made for each temperature that was studied.

Each sample was placed in a coagulation tube 10 minutes before addition of the rennet in order to adjust itself to the temperature of the bath. One ml. of a 3 per cent rennet solution was added to each 50 ml. of milk, a stopwatch started and the milk stirred for 30 seconds. After an appropriate interval the screw clamp closing the bottom of the coagulation tube was re-

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leased slightly and a fine stream of milk allowed to run into a beaker. When coagulation was observed on the sides of the glass the watch was stopped and the coagulation time recorded.

In each series of experiments unheated control samples were coagulated with rennet at the beginning and again at the completion of the experiment. During the 3 hour interval the raw milk was held at 20° C. In all cases the coagulation time of these control samples was easily within experimental error.

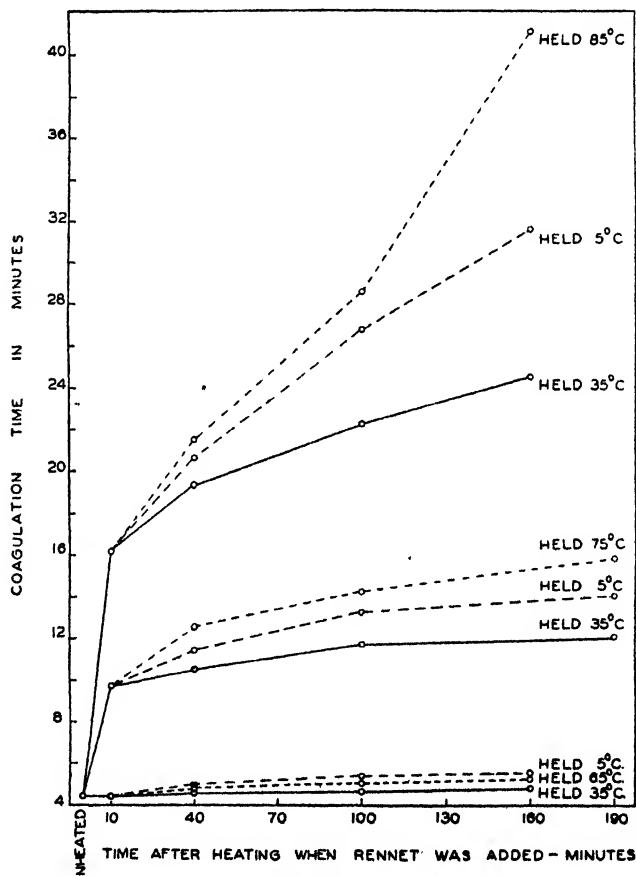


FIG. 1. Typical coagulation curves of skimmilk heated at 65°, 75° and 85° C. for 30 minutes and coagulated with rennet at 35° C. after aging for various intervals at 5°, 35° C. and at the heating temperature. Lower group of curves represents milk heated at 65° C., the middle group 75° C. and the upper group 85° C.

The typical coagulation curves of the milks heat-treated by the holding method are presented in Fig. 1. This graph shows the relation of the time

of coagulation to the interval after the initial heating period when rennet was added. There are three distinct groups of curves; the lower group represents milks which were initially heat-treated at 65° C., the middle group those milks heated at 75° C. and the upper group those milks heat-treated at 85° C.

If one compares the immediate effect of heating on the coagulability it is readily seen that the coagulation time increases with the temperature of heat-treatment, a fact which has been known for many years. However, when milk is heated at 65° C. for 30 minutes and rennet added immediately at a lower temperature (35° C.) there is an actual acceleration in the rate of coagulation. The scale of the graph is too small to show the slight acceleration which usually occurs. It is more pronounced in some milks than in others. This increased coagulability as a result of low temperature heating was first observed by Stassano and Talarico (4) and later confirmed by Rupp (5) and Mattick and Hallett (2). When the temperature of heat-treatment is increased from 65° C. to 75° C. the effect is to decrease the initial coagulability slightly more than one-half, while heating at 85° C. caused a greater retardation, the milk requiring 4 times as long to coagulate as the unheated control.

The coagulation time of the heat-treated milks does not remain constant but gradually increases as these milks are aged before the addition of rennet. Aging of the milks initially heated at 65° C. only slightly retards their coagulability, whereas the retardation becomes more pronounced as the initial heating temperature increases. Furthermore, the temperature at which the heat-treated milks are held also influences their rate of coagulation. Regardless of the initial heating temperature, in all cases those portions held at 35° C. coagulate more rapidly than those held either at 5° C. or at the initial heating temperature.

Aging the heat-treated milks at 5° C. retards coagulation less than holding at the heating temperatures of 75° C. or 85° C. Again, those milks heated initially at 65° C. show the least effects of aging at different temperatures, the differences becoming more pronounced as the initial heating temperature is raised.

The change in pH as the result of heat-treatment is negligible, rarely exceeding 0.01 pH even at the highest temperature used. The slight change which does occur is always towards a lower value which should tend to cause a more rapid coagulation if there be any effect.

STUDIES WITH FLASH PASTEURIZED MILK

In this part of the study the procedure of aging the various portions of milk heat-treated by flash pasteurization was identical with that already described. A convenient laboratory flash pasteurizer was constructed with three different sizes of tinned-copper sanitary piping 1, 1.5 and 2 inches in

diameter; it is similar to the one described by Moir (3). A diagrammatic sketch of the pasteurizer is shown in Fig. 2. The one inch pipe is two feet

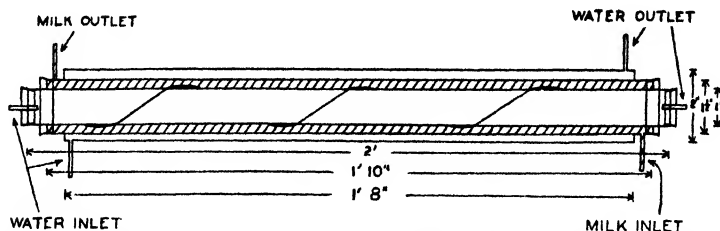


FIG. 2. Design of experimental flash pasteurizer constructed with 1, 1.5 and 2 inch diameter tinned-copper sanitary piping. Shaded portion is the milk chamber.

long and the 1.5 inch pipe is 2 inches shorter while the largest one is 2 inches shorter than the intermediate one. The pipes were telescoped, the two largest ones being uniformly spaced and soldered together while the smallest pipe was fitted into the intermediate one with rubber stoppers. This arrangement permitted easy cleaning of the surfaces which came in contact with the milk. A No. 10 gauge wire was soldered in a spiral around the one inch pipe in order to produce greater agitation of the milk during heating. Appropriate inlets and outlets were soldered into the intermediate and outer pipes, the center pipe being closed on each end with rubber stoppers through which short pieces of glass tubing were inserted.

During the actual operation the unit was placed vertically and the milk permitted to flow by gravity through the intermediate passage. Hot water 10 to 15° C. higher than the final temperature of the milk was pumped through the center and outer passages. The flow of milk was regulated so as to require from 30 to 45 seconds exposure to reach a temperature of 75° C. or 85° C. Approximately 5 minutes were required to collect the two liters of heated milk necessary for each experiment.

The portion of the heated milk held at the pasteurizing temperature was run directly into a flask and immediately immersed in a water bath of the same temperature. The remainder of the milk was allowed to flow from the pasteurizer directly through a Liebig condenser cooled with tap water and emerged at approximately 35° C. One-half of the cooled milk was placed in a flask and the temperature adjusted exactly to 35° C.; it was held at that temperature in a water bath. The other portion of the milk was promptly cooled to 5° C. by immersing the flask in ice-water.

Immediately after the first portion of milk had been adjusted to 35° C. two 50 ml. samples were withdrawn and rennet added for coagulation. Duplicate 50 ml. samples from each of the above portions of milk were adjusted to 35° C. at various intervals after heating and rennet added. One ml. of a 3 per cent rennet solution was added to each 50 ml. for coagulation, the procedure being identical with that previously described.

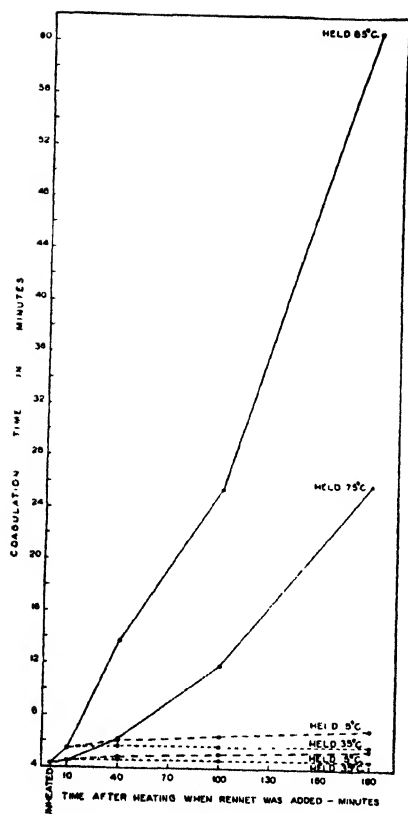


FIG. 3. Typical coagulation curves of skim milk flash pasteurized at 75° and 85° C. and coagulated with rennet at 35° C. after aging for various intervals at 5°, 35° C. and at the heating temperature. Open circles represent milks heated at 75° C., solid circles heated at 85° C.

The typical coagulation curves in Fig. 3 are of milk heat-treated by flash pasteurization at 75° C. and 85° C. and show the relation of the coagulation time to the interval after heating when rennet was added. The initial effect of the temperature of heating, as shown in these curves, is a retardation of the coagulability; this effect increases with the heating temperature but is not so pronounced as in the milks heated by the holding method. In fact, only a very slight decrease in coagulability is registered by flash pasteurizing milk at 75° C. Likewise the effects of aging flash pasteurized milks at 5° C. and 35° C. are less pronounced than when the holding method of pasteurization is used.

When different aging temperatures are employed the least effects on coagulability are again registered by those portions held at 35° C. followed closely by those samples held at 5° C. Naturally, prolonged holding at the heating temperatures of 75° C. or 85° C. greatly retards coagulation, the highest temperature producing the most pronounced effect.

DISCUSSION

These experimental results indicate that there may be several factors involved in the hysteresis-like phenomenon previously (1) referred to. The time and temperature of aging as well as the temperature of heat-treatment play major rôles. Certainly the initial heating temperatures are of prime importance in influencing the rate of coagulation, especially when the milk is heat-treated by the holding method. These temperatures in turn affect the later behavior during aging, particularly in those milks heated at the higher temperatures.

The effect of the duration of heating is clearly indicated in the flash pasteurization study. Only slight decreases in the rate of coagulation were produced in those heated portions which were promptly cooled after heating while progressively larger losses occurred as portions were aged at the heating temperatures. The same effects were produced in the milks heated by the holding method but were less pronounced. When the two methods of heating are compared it is readily seen too that the short-time heating produces far less retardation in the heated portions than the holding method does.

It is remarkable that all of the heated samples that were aged at 35° C. coagulated more rapidly than those held at 5° C. One would suspect that the higher holding temperature would result in greater losses of coagulability, yet the reverse was true in all cases studied. An adequate explanation of this behavior has not yet been found. Apparently it is not due to an inadequate warming of the cold samples as several trials were made in which those samples were first warmed to 40° C. and promptly cooled to 35° C. before addition of the rennet; no significant differences occurred.

CONCLUSIONS

1. Heat-treating milk at 65° C. for 30 minutes and cooling to 35° C. does not retard its coagulability if rennet is added immediately after heating; in fact, slight increases generally occur.

2. Aging of milk heat-treated at 65° C. for 30 minutes at either 5°, 35° or 65° C. for 3 hours only slightly retards its coagulability.

3. Heat-treating milk at 75° or 85° C. for 30 minutes definitely retards its coagulability with rennet at 35° C.; the loss increases as the heating temperature rises.

4. When milks heat-treated at 75° or 85° C. for 30 minutes are aged at 5°, 35° or at the heating temperature a progressive loss of coagulability results as rennet addition is delayed. The retardation is most pronounced in the milks heated at 85° C.

5. Aging heat-treated milks at 35° C. retards coagulability less than aging at 5° C. or at the heating temperature; the greatest loss occurs when the milks are held at the heating temperature, except those at 65° C.

6. Flash pasteurization of milk at 75° C. only slightly retards its coagulation with rennet at 35° C.; no change in the rate occurs after aging 3 hours at 35° C. and only a slight loss results at 5° C. Holding this milk at the heating temperature naturally causes sharp increases in coagulation time.

7. Flash pasteurization of milk at 85° C. decreases the rate of coagulation but the retardation is not as great as milk heated at 75° C. by the holding method. Aging this milk at 5° or 35° C. causes further small losses in coagulability while holding at 85° C. results in a drastic retardation.

I wish to express my appreciation to Dr. L. S. Palmer, Professor of Agricultural Biochemistry, University of Minnesota, for his encouragement and valuable council.

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EFFECT OF TANKAGE ON THE FLAVOR OF MILK

T. M. OLSON, C. C. TOTMAN, AND G. C. WALLIS

South Dakota State College, Brookings

Tankage is not ordinarily fed to dairy cows but during the 1934-35 feeding season many dairymen fed it as a protein supplement because of its relatively low price. We became interested in and organized a trial to determine the effect of tankage on the flavor of milk.

We experienced difficulty in getting the cows to eat tankage. Some cows refused their grain when as little as a tablespoonful of tankage was mixed with eight to ten pounds of the concentrate mixture. We selected four cows from 32 which would eat the tankage in large quantities when mixed with the concentrate part of the ration. In the group of four cows was one Jersey, one Ayrshire, one Holstein and one cross-bred cow. All had sound udders free from garget. The cows were in approximately the same stage of lactation.

The cows were on the regular herd ration consisting of four parts of oats, four parts of barley, three parts of bran, and two parts of oil meal. Corn silage and a fair grade of alfalfa hay were fed as roughage. The grain ration was fed according to milk production.

The four cows produced an average of 14.07, 29.72, 31.40 and 13.62 pounds of milk respectively per day during the test period. The four cows showed no daily variation of any significance during the seven periods. The cows were receiving 5, 7, 8 and 5 pounds of the grain mixture daily.

When the tankage feeding was begun 25 per cent by weight of the grain ration was replaced by an equal amount by weight of tankage. This level of tankage feeding was continued for four consecutive days, when the tankage was increased to 33½ per cent of the grain ration and continued for a second four-day period. Tankage was then increased to fifty per cent of the concentrate ration and continued for the third four-day period.

The concentrate ration and roughage were fed after milking according to the regular barn procedure. Following the 50 per cent tankage-feeding-period fed after milkings, the concentrate part of the ration containing 50 per cent tankage was fed one hour before milking for four consecutive days, and then the time of feeding was changed to two hours before milking, and the feeding continued for another period of four days.

Armour's Feeding tankage was used. The supply of tankage was secured from the supply purchased by the Animal Husbandry Department for hog feeding.

One-half pint sample of milk was taken from each cow at the P.M. milking. The sample was poured directly from the milk pail without cooling or

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aerating. The sample bottles were capped and placed in cold water until 8 A.M. when they were delivered to the Creamery, where they were stored in the refrigerator at a temperature of 40° F. The samples were scored in the afternoon of each day approximately at the same time. The samples were therefore approximately 24 hours old when scored.

The samples were taken out of the refrigerator and heated to about 95° F. and then scored by five judges. Only one of the judges knew the plan of feeding, and the individual cows from which the samples were taken. Each judge scored the milk for flavor only, indicating the score of the milk as excellent, good, fair and poor. Grades in between were indicated by plus or minus. In order to facilitate the compilation of the data, numerical values ranging from 14 to 25 have been placed on the twelve scores.

RESULTS

Table 1 shows the average scores of the milk from the four cows. The average score as given for each judge represents 16 observations, and the average of all judges 80 independent observations.

TABLE 1

*Average score of the milk of four cows for seven consecutive experimental periods as given by the individual judges, together with the average score by all the judges**

INITIAL OF JUDGES	O	T	W	C	K	AV.
Herd ration fed after milking	20.85	20.90	20.60	20.35	21.35	20.81
25 per cent tannage " "	21.00	21.75	20.50	20.50	21.50	21.05
33½ " " " " "	20.93	20.37	21.50	20.25	21.00	20.81
50 " " " " "	21.20	21.73	21.60	20.09	21.20	21.16
50 " " " one hr. before	20.87	21.00	21.12		20.87	20.96
50 " " " two hrs. "	21.00	20.31	20.56		20.56	20.60
Herd ration after 4 day interval	20.87	20.87	20.68	20.21	21.20	20.76

* Each score by individual judges represents the average of 16 independent observations, and the average score by all the judges represents the average of eighty observations.

A study of the data indicate very close agreement by the several judges. The greatest fluctuations for the seven periods is from a numerical score of 20.09 to 21.75.

The greatest variation in any one period was from 20.09 to 21.73, which occurred during the 50 per cent tannage feeding period. However the one judge who placed the low score on this series of samples was scoring consistently lower than the other four judges.

The average score of all judges for all periods did not show any appreciable difference. The score of 20.81 previous to the tankage feeding trials, checks very closely with the subsequent tankage feeding periods. The highest average score as well as the highest score of two judges occurred during the 50 per cent tankage feeding period.

The data in Table 2 indicate that the samples of milk from the four cows varied more due to individuality than to the rations fed.

TABLE 2

*Average score of the milk from each of the four cows for the seven consecutive 4-day experimental periods**

	COW NO	106	3 B	383	227
Herd ration fed after milking		18.92	21.28	20.84	21.84
25 per cent tankage " "		20.47	20.95	20.84	21.68
33½ " " " " "		20.38	20.94	21.00	21.00
50 " " " " "		20.67	22.00	21.47	21.00
50 " " " one hr. before milking		20.75	21.56	19.93	21.37
50 " " " two hrs. " "		20.62	21.13	19.68	20.43
Herd ration after 4-day interval		21.21	21.84	19.43	20.23

* The score for each cow for each period represents the average of twenty independent observations

The samples from cows 227 and 3-B were not criticized for off flavor, except on two or three occasions. Samples from cow 106 were criticized very often for having a salty taste. The samples from cow 383 were criticized as watery, sweet, bitter.

It is well known that milk from individual cows varies greatly in flavor, when no specific cause can be given. The samples of milk from cow 227 showed a higher average score than the milk from any other cow. The milk from 3-B, showed the widest variation.

Our findings so far as the effect of tankage on flavor of milk is concerned are essentially the same as reported in Massachusetts Agric. Exp. Station bulletin 321 in which the author concludes: "that the tankage did not effect flavor of the milk in any way."

CONCLUSIONS

1. The feeding of tankage in the grain ration in amounts as high as 50 per cent by weight appears to have no effect on the flavor of milk.
2. The flavor of milk was not affected by the time of tankage feeding even when the tankage was fed one and two hours prior to milking.
3. There were greater variations in the scores of milk samples from individual cows than occurred as a result of tankage feeding during the different periods.

CORN GLUTEN FEEDING AND THE TITRATABLE ACIDITY OF MILK

ELMER O. ANDERSON, GEORGE C. WHITE AND ROBERT E. JOHNSON*

Storrs Agricultural Experiment Station, Storrs, Connecticut

INTRODUCTION

The acidity test of milk has been used for some time as a basis for accepting or rejecting milk upon its arrival at milk plants. It provides a quick method at the time of delivery to the plant and its use has been continued although several investigators have shown that misleading information may be secured if the quality of milk is judged solely on the titratable acidity. The usual practice is to reject milk with an acidity above 0.175 per cent.

A representative of one company observed certain farmers producing milk of high acidity who were feeding large amounts of corn gluten feed, one to the extent of 75 per cent of the grain ration. Sulphuric acid is used in the process by which gluten feed is produced. At the suggestion of the company's field representative the corn gluten feed was reduced in this herd, after which the milk passed the weigh stand acidity test.

This matter was referred to the writers, who have since undertaken to determine whether or not large amounts of corn gluten feed in the ration affect the titratable acidity of milk.

Turner and Beach (6) in 1904 found that ensilage in the ration did not increase the titratable acidity of milk.

Duncombe (1) fed lactic acid, acetic acid, butyric acid and phosphoric acid to cows but failed to alter the acidity of milk.

Sommer and Hart (4) have tested the effect on the acidity of milk of feeding concentrated sulphuric acid. They fed up to 120 c.c. of sulphuric acid per day for six days and the acidity of the milk remained unaltered.

Recently, Sommer (5) has ably reviewed the literature and discussed the factors that influence the acidity of milk and milk products and concludes: "Feeding experiments in an attempt to alter the gross chemical composition of milk (fat, casein, total solids content) have in general led to the conclusion that it is impossible to alter the composition of milk in any definite manner. Experimental evidence indicates that a similar conclusion must be drawn with respect to acidity."

FIRST TRIAL

To ascertain the effect of corn gluten feed on the acidity of freshly drawn milk, a ration was made consisting of:

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* The first trial of this series of two was conducted by H. Wilmot Carter and reported in 1934 as a thesis in partial fulfillment of the requirements for the Master's degree.

70 per cent corn gluten feed
10 per cent wheat bran
10 per cent crimped oats
5 per cent linseed oil meal (O. P.)
5 per cent corn hominy

This will hereafter be referred to as the "gluten ration."

The control ration consisted of:

20 per cent wheat bran
20 per cent crimped oats
40 per cent linseed oil meal (O. P.)
20 per cent corn hominy

This will hereafter be called the "no-gluten ration."

Each mixture contained approximately 20 per cent total crude protein. Ten pounds of sodium chloride was added to each one thousand pounds of grain mixture.

The regular herd ration was fed to a third group. This ration, which contained about 20 per cent corn gluten feed, will hereafter be called the "herd ration."

Each animal was fed the same roughage: Two feedings of alfalfa hay, one feeding of native mixed hay, and three light feedings of corn silage per day. The animals were milked three times a day. The milk was titrated with N/10 NaOH immediately after each milking.

Three Ayrshires, two Guernseys and six Holsteins were selected for study. All animals had freshened normally within ten weeks of the beginning of the experiment and were mastitis-free as determined in routine tests by the methods of Plastringer, *et al.* (2, 3). The cows were divided into three groups. Groups I and II each consisted of one Ayrshire, one Guernsey and one Holstein. Group III (control) consisted of one Ayrshire and two Holsteins. One of the remaining two Holsteins was fed the gluten ration and the other the non-gluten ration continuously. Group III received the herd ration continuously, while Groups I and II were subjected to reversal feeding.

The reversal feeding project was divided into three periods of twenty days each for Groups I and II, with two five-day and one eleven-day transition periods. Group I was started on the gluten ration, shifted to the no-gluten ration, and finally returned to the gluten ration, while Group II followed just the opposite course. The entire trial covered 81 days.

The results are given in Table 1 and Table 2.

The reversal fed groups gave no evidence whatsoever of any influence of corn gluten upon the titratable acidity of milk.

The animal fed the gluten ration continuously for 81 days showed a steady increase in titratable acidity from 0.184 per cent in the preliminary

TABLE 1
Effect of feeding corn gluten on the titratable acidity of milk

PERIOD	GROUP ONE		GROUP TWO		CONTROL GROUP	
	Ration	Acidity <i>per cent</i>	Ration	Acidity <i>per cent</i>	Ration	Acidity <i>per cent</i>
Prior	Herd	0.190	Herd	0.190	Herd	0.182
1st	Gluten	0.189	No-gluten	0.196	"	0.184
2nd	No-gluten	0.188	Gluten	0.197	"	0.187
3rd	Gluten	0.186	No-gluten	0.196	"	0.183

TABLE 2
Effect of continuous feeding of corn gluten on the titratable acidity of milk

PERIOD	GLUTEN MIXTURE	NO-GLUTEN MIXTURE
	Acidity	Acidity
Prior	<i>per cent</i> 0.184	<i>per cent</i> 0.180
First	0.190	0.178
Second	0.194	0.175
Third	0.197	0.169

period to 0.197 per cent during the third period. The animal fed the no-gluten ration continuously showed a steady decrease in titratable acidity from 0.180 to 0.169 per cent. The results with these two animals point to gluten feed influence, since the milk of the one on high gluten feed steadily increased in acidity while the one on no-gluten feed gave steadily decreasing readings of acidity, both having been changed from a herd ration containing a moderate amount of gluten feed. This result led to arrangements for a second trial.

SECOND TRIAL

To check the effect of protracted high gluten feeding, two Ayrshires, two Jerseys and two Holsteins were selected and divided into two groups, as follows:

Group I—An Ayrshire, a Jersey and a Holstein, fed continuously on a gluten feed mixture

Group II—An Ayrshire, a Jersey and a Holstein, fed continuously on a no-gluten feed mixture

The animals of each breed were paired. Due to unavoidable conditions the two Ayrshires were removed from the experiment after forty-seven days.

The gluten feed mixture consisted of 70 per cent corn gluten feed, 5 per cent standard wheat bran, 5 per cent (42 lb.) ground oats, 20 per cent white hominy feed, and contained 22.19¹ per cent crude protein.

The no-gluten ration consisted of 40 per cent linseed oil meal (O. P.), 20 per cent standard wheat bran, 20 per cent (42 lb.) ground oats, 20 per cent white hominy feed, and contained 23.38¹ per cent crude protein.

Each of the above rations contained an additional one per cent steamed bone-meal and one per cent sodium chloride.

The feeding and milking routine were the same as in the first trial. The milk samples were brought to the laboratory and titrated with N/10 NaOH within two hours after milking instead of in the milk room immediately after milking as in the previous trial.

The results of the second trial are summarized in Table 3, the data for each period representing the average titratable acidity for thirty days.

TABLE 3
Gluten feed and the titratable acidity of milk

PERIOD	NO-GLUTEN MIXTURE			GLUTEN MIXTURE		
	Ayrshire	Jersey	Holstein	Ayrshire	Jersey	Holstein
	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>
Prior	0.187	0.165	0.188	0.166	0.178	0.158
First	0.183	0.165	0.180	0.160	0.169	0.162
Second	0.182	0.167	0.178	0.160	0.173	0.163
Third		0.162	0.178		0.176	0.158
Fourth		0.161	0.181		0.174	0.168
Fifth			0.175			0.159
Days	47	118	131	47	118	131

In the second trial there was no observable trend in the apparent acidity of either group. There were differences in the individual behavior of the animals but nothing that can be translated into terms of group response.

DISCUSSION

A study of the results indicates that feeding corn gluten feed in relatively large amounts did not increase the titratable acidity of the milk.

The percentage of acidity of the milk from twenty-nine animals in the herd, free from mastitis and apparently normal in other respects, was 0.190 with a standard deviation of $\pm .015$, a reading that would subject their milk to rejection. It is an established fact, observed in this study also, that

¹ Analysis made by the Connecticut (New Haven) Experiment Station.

the fresh milk of breeds producing milk of high solids content is relatively higher in titratable acidity than is the milk of lower solids-yielding breeds.

CONCLUSIONS

Two trials were conducted, one over a period of 81 days and another over periods of 47, 118 and 131 days, to compare the titratable acidity of fresh milk from cows whose grain rations varied from no-gluten feed to 20 per cent gluten feed (herd ration) and 70 per cent gluten feed by weight.

The results of the two trials indicate that corn gluten feed in the ration is not a factor which influences the titratable acidity of milk.

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THE EFFECT OF THE ADSORPTION "MEMBRANE" AROUND THE FAT GLOBULES ON THE CURD TENSION OF COW'S MILK*

L. S. PALMER AND N. P. TARASSUK

Division of Agricultural Biochemistry, University of Minnesota, St. Paul

According to Lundstedt (1) the relatively low curd tension exhibited by buttermilk is caused by the adsorption on the casein of the lecithin removed from the fat globules during churning. In support of this hypothesis Lundstedt shows (1) that the curd tension of the skim milk fraction of mixtures of skim milk and whipped cream varies inversely with the rise in the cream fraction; (2) that there is a coincident rise in the lecithin which may be extracted from the casein precipitated from the skim milk by HCl. In further support of his hypothesis Lundstedt asserts that whole milk which has been agitated at low temperature exhibits a greatly reduced curd tension because of the removal of sufficient lecithin from the fat globules during the treatment. Indeed, he has been granted a patent (2) for thus producing soft-curd milk.

It is obvious that Lundstedt's lecithin data lack the crucial test of observing the effect of the direct addition of lecithin to milk. We were fortunate in having available for such a test a quantity of unoxidized phospholipide complex¹ prepared from egg yolk. When we failed to secure a reduction in curd tension either through adding this phospholipide to milk or by agitating milk at low temperature, whereas it was found that sweet cream buttermilk does show a reduced curd tension it seemed obvious that further experiments as well as another hypothesis were required to explain the latter result. This paper reports some of the additional studies we have made of this problem.

EXPERIMENTAL

General methods employed.—Curd tension data, being obtained by an empirical procedure, are not to be regarded as absolute values. In our studies the data are comparable only in experiments involving the same sample² of milk and the same coagulant. In certain experiments the Hill

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¹ The phospholipide complex was a mixture of pure lecithins and cephalins containing approximately 80 to 85 per cent lecithins, prepared by the method of Sueyoshi (3) as modified by H. B. Bull and V. L. Frampton (4) of the Division of Agricultural Biochemistry of the University of Minnesota. The product was a colorless, paraffin-like wax readily dispersible in aqueous media to form colloidal sols.

² The milk for these experiments was in all cases fresh raw mixed milk from the Minn. Agr. Experiment Station dairy herd. Preliminary study using the Hill coagulant showed

(2) coagulant (pepsin- CaCl_2) was used, in others pepsin alone, in others rennet extract. In all experiments sufficient coagulant was used to cause

TABLE 1
Effects on curd tension of adding phospholipides to whole milk and skim milk

EXP NO	METHOD OF ADDING LECITHIN	CURD TENSION ¹					
		WHOLE MILK			SKIM MILK		
		BLANK	CON-TROL	LECITHIN ADDED	BLANK	CON-TROL	LECITHIN ADDED
		grams	grams	grams	grams	grams	grams
1a (initial)	trituration and emulsifying	60	62	61	95	> 104	> 102
1a (24 hrs.)	trituration and emulsifying	75	69	68	92	88	88
1b (initial)	addition of aqueous sol				95	82	91
1b (24 hrs.)	addition of aqueous sol					79	80
2	trituration, emulsifying and agitation at low temp.				98	88	91

¹ Using Hill coagulant for experiment 1 and pepsin alone for experiment 2.

clotting within one-half minute. Other conditions were in accordance with the standard Hill test, except that the older curd knives (diam. 2 inches) and the special Chatillon spring balance were employed. The data reported are the average of duplicate or more readings agreeing within approximately 10 per cent, usually within much closer range (except for high curd tensions for which exact duplicates are difficult by the knife method). Hydrogen ion concentrations when determined were usually by the electro-metric method, using the Bailey electrode except where indicated. Special procedures are described in connection with the several experiments.

Effect of adding phospholipide to milk.—Two experiments were conducted involving the direct addition of pure phospholipides to milk. In the first experiment a comparison was made of adding the phospholipide by two methods; (a) trituration of the waxy solid in a mortar with a small volume of the milk, addition of this preparation to the larger volume of milk on which curd tension was to be determined and passage of this mixture once through a hand emulsifier;³ (b) addition of an aqueous sol⁴ of the that this milk had a curd tension of 65–70 grams under the conditions employed, the skim milk showing values from 90 to 100 grams. With rennet extract as coagulant the values were about 30 per cent lower.

³ A Club Aluminum Products Co., 12 oz. hand "homogenizer" was found suitable for this purpose.

⁴ The volume of water employed was 15 ml. added to 300 ml. milk.

lecithin to the milk. The experiment also involved the effects of the phospholipide on both whole milk and skim milk and the effect of aging the mixes for 24 hrs. at 5° C. Blank curd tensions were run on untreated portions of the whole milk and skim milk, and also "controls," i.e., samples of whole milk and skim milk which had the same treatment as the experimental samples other than the addition of phospholipide. In one experiment this involved trituration of a small portion of the milk in a mortar and passage of the entire milk through the emulsifier, and in the other experiment the addition of water equal to that added in the aqueous phospholipide sol. Sufficient phospholipide was used to give a concentration of 0.35 per cent of added product in the final milk.

The second phospholipide experiment was conducted with skim milk. The object was to determine whether the lack of effects secured in experiment 1 could have been due to an oxidation of the phospholipide complex and or a failure to allow the phospholipide sufficient opportunity to be adsorbed by the casein. Since phospholipide seems to be readily adsorbed by the fat globules it seemed advisable to limit this experiment to skim milk in order to avoid any competition between the casein and the fat globules for the added phospholipide. For these purposes the colorless, waxy phospholipide was taken directly from the acetone in which it was suspended, dried between filter papers, weighed rapidly, trituated to a colloidal sol in a small volume of warm skim milk and transferred to a large volume of skim milk which was then passed through the hand emulsifier; the emulsified mixture was cooled to 4° C. and churned for 60 minutes in a glass Dazey churn and then allowed to stand over night at 5° C. This experiment also involved a "blank," which had merely been kept cold and a "control" which had been carried through all the mechanical treatments without the addition of phospholipide. Sufficient phospholipide was employed in this experiment to give a 0.575 per cent concentration in the final milk. This is nearly twice the maximum phospholipide concentration in buttermilk reported by Holm, Wright and Deysher (5).

The results of these experiments are shown in table 1. No important changes are noticeable, which are not likewise shown by the control samples.

Effects of churning and of agitation at low temperature.—Three experiments were conducted to compare the curd tension of various samples of whole milk, skim milk, buttermilk and agitated⁵ whole and/or skim milk when these various products originated from the same lot of fresh whole milk. The curd tension determinations were repeated on the buttermilk after standing for several days at 5° C. to ascertain whether the reduced curd tension is permanent. Tarassuk and Richardson (6) have observed

⁵ The agitation experiments were carried out in glass Dazey churns immersed in a water bath at the desired temperature, the agitation exceeding normal churning speed.

that the reduction in curd tension of milk following homogenization at pressures of 1,500 to 2,500 lbs. at 100° F. is partially restored on standing.

The results are shown in Table 2. It is evident from these data that buttermilk shows a definitely and permanently reduced curd tension, in comparison with both its corresponding whole milk and skim milk but that this effect is not duplicated by the agitation of milk; in fact the only apparent reduction due to agitation occurred in samples of separator skim milk (exps. 1 and 3) which contained no fat globule "membrane" substances. Agitation experiment 1 (b) was conducted on samples of the same milk fractions as experiment 1 (a) after having stood in the cold room for 24 hours.

TABLE 2
Comparative curd tensions of whole milk, skim milk, buttermilk and the effect of incipient churning

EXP.	SAMPLE	CURD TENSION ¹
		grams
1 (a)	Original whole milk ²	70
	Skim milk	> 103
	Buttermilk ³	47
	Buttermilk after 60 hours standing	49
	Whole milk agitated at 20° C. for 22 min.	73
	Skim milk " " " " " "	90
1 (b)	Whole milk agitated at 5° C. for 22 min.	82
	Skim milk " " " " " "	> 101
2	Original whole milk	74
	Buttermilk	55
	Buttermilk after 60 hours standing	50
	Whole milk agitated at 5° C. for 50 min.	73
	Agitated whole milk after 60 hours standing	66
3	Skim milk	90
	Buttermilk	44
	Skim milk agitated at 4° C. for 60 min.	88

¹ Using Hill coagulant.

² pH 6.66.

³ pH 6.59.

Effect of fat globule "membrane" complex on curd tension.—Palmer and Samuelsson (7) and Palmer and Wiese (8) have shown that the natural fat globule "membrane" of cows milk which is released during the churning of cream, is a phospholipide-protein complex which is not coagulated by rennet. Preliminary tests showed that a concentrated sol of crude "membrane," prepared from the buttermilk of churned, washed cream, would lower the curd tension of a skim milk control⁶ below that of its

⁶ The skim-milk control was diluted with the same volume of water as that of the concentrate of "membrane" material, but no water was added to the corresponding whole milk.

corresponding whole milk. The following is a typical result when using the Hill coagulant.

Curd tension of skim milk control	77 grams
Curd tension of whole milk	72 grams
Skim milk plus "membrane" sol	58 grams

Further preliminary tests showed that it is necessary to employ freshly prepared and carefully concentrated "membrane" sols in order to demonstrate their optimum curd-tension reducing properties.

Two principal experiments were conducted. In general both consisted of a comparison of curd tensions of skim milk following the addition of either concentrated "membrane" complex or concentrated plasma solids. Both experiments also involved a number of suitable controls. For example, in both experiments we compared the curd tension of a natural buttermilk and that of a buttermilk from a sample of the same cream which had been thoroughly washed with water and then rewashed with skim milk. Also in both experiments an attempt was made to control the "solids" added to the skim milk as "membrane" complex concentrate or plasma concentrate, respectively. The experiments differed primarily in the nature and extent of this control. In the first experiment the control was somewhat crude in that the plasma concentrate consisted of a sample of skim milk in which one per cent fat had been emulsified and the low-fat "synthetic" skim concentrated by pervaporation⁷ to the total solids content of the "membrane" complex concentrate, *i.e.*, about 30 per cent. In the second experiment the plasma concentrate consisted of a sample of dialyzed skim milk, essentially free from lactose and soluble salts, in which butterfat was emulsified to give the same fat/solids-not-fat ratio⁸ as the buttermilk from the washed cream. This was diluted with distilled water to the total solids content of the washed cream buttermilk and the two sols pervaporated at the same time to the same concentration (approximately one-tenth the original volume). Both experiments had as controls the curd tension of the untreated skim milk from the original lot of whole milk and which was likewise used for washing the creams following the water-washing.

The "membrane" complex was prepared in each case by washing fresh 35-40 per cent cream four times, each with four volumes of distilled water at 100° F., and churning this cream.

⁷ The material is put in 12-15 inch lengths of 18-20 mm. (diam.) Visking casings which are tied at both ends and suspended over an electric hot plate toward which an electric fan is directed. This method of evaporating colloidal sols without heat treatment is rapid and efficient. It has been used for many years in this laboratory and was first described in principle by Kober (J. Am. Chem. Soc. 39: 944, 1917).

⁸ The fat content employed was based on the "true" fat content of the buttermilk from the washed cream, which was determined by the Minnesota Babcock method, using the Minnesota reagent.

The results are shown in Table 3, which also shows the composition of the concentrates added to the skim milk fractions. There can be no ques-

TABLE 3

Curd tension of skim milk before and after addition of colloidal concentrates of fat globule "membrane" and milk plasma (natural and dialyzed) in comparison with curd tension of natural buttermilk and buttermilk from cream washed with water and rewashed with skim milk

EXPERIMENT	PRODUCT TESTED	CURD TENSION ¹	VOLUME OF CONC. ADDED	COMPOSITION OF CONCENTRATE		
				TOTAL SOLIDS	FAT	SOLIDS-NOT-FAT
		grams	per cent	per cent	per cent	per cent
1	Original skim milk	61				
	Natural buttermilk	39				
	Buttermilk from cream rewashed with skim milk	44 ²				
	Skim milk plus "membrane" conc.	42	10.0	28.4		
	Skim milk plus plasma conc.	>100	10.0	31.2		
2	Original skim milk	60 ³				
	Natural buttermilk	34				
	Buttermilk from cream rewashed with skim milk	39				
	Skim milk plus "membrane" conc.	39 ⁴	7.6	9.52	1.04	8.48
	Skim milk plus plasma colloid conc.	65 ⁵	7.6	9.46	2.08	7.38

¹ Using rennet extract.

² Using Hill coagulant.

³ pH 6.33.

⁴ pH 6.34 (quinhydrone).

⁵ pH 6.30 (quinhydrone).

tion that these data demonstrate conclusively the curd-tension reducing effect of the "membrane" complex. In experiment 1 the amount of concentrated solids-not-fat added to the skim milk undoubtedly increased the solids-not-fat of the skim milk, as evidenced by the very high curd tension of the skim milk containing added plasma concentrate, and yet the curd tension of the skim milk containing added "membrane" concentrate was essentially the same as that of the natural buttermilk. In experiment 2 the solids-not-fat of the skim milk were slightly diluted (5% or less) by the concentrates, but the curd tension of the skim milk with added "membrane" was much lower than could be accounted for by so slight a dilution, and the curd tension of the skim milk with added plasma colloid concentrate

was actually increased slightly (as would be expected). Further proof of the curd tension reducing effect of "membrane" complex is seen in the reduced curd tensions of the buttermilk from the creams which had been washed with water and the water replaced by skim milk in a subsequent washing. The curd tension of these buttermilks was essentially the same as that of the natural buttermilk from other portions of the same creams.

Effect on curd tension of "membrane" adsorbed by fat globules emulsified in buttermilk from washed cream.—Having demonstrated that it is the natural fat globule "membrane" complex released during churning which is responsible for the lower curd tension of buttermilk we sought to determine whether butterfat globules will readorb this complex from the buttermilk of washed cream and release it again into normal milk plasma (skim milk) and cause a reduction in the curd tension of the buttermilk thus produced.

Fresh, sweet cream, containing 35 per cent fat, was washed four successive times, each with four volumes of distilled water at 100° F. After standing over night at 5° C, the temperature was raised to 12° C. and the cream churned. The free buttermilk was warmed to 38° C. and sufficient fat emulsified with it to produce an artificial 35 per cent cream. The emulsification was carried out by means of the hand homogenizers,⁹ producing a stable emulsion. This was diluted with fresh skim milk to a fat content of 3.8 per cent. A portion was saved for curd tension tests and the remainder separated into a "remade" cream and a "remade" skim milk. The cream tested 25 per cent fat. A portion of the skim milk was saved for curd tension tests. The separation was carried out with the laboratory Sharples supercentrifuge geared down to 12,000 r.p.m. In order to secure a normal separation a portion of normal whole milk was first passed through the centrifuge. The first skim milk and cream portions corresponding to the volume of normal whole milk used, were discarded. Portions of the "remade" skim milk were saved for curd tension. The "remade" cream thus obtained churned normally in 40–45 minutes after proper temperature adjustment. The "remade" buttermilk from this churning was saved for curd tension tests. Analyses of this buttermilk showed 0.3 per cent fat and 8.2 per cent total solids. The curd tension results are shown in Table 4 in comparison with the curd tension of portions of skim milk and buttermilk from the original cream.

The data are a remarkable demonstration of both the emulsifying properties of the "membrane" complex and its rôle in determining the decreased curd tension of buttermilk. It may also be remarked that although

⁹ The material was passed through the two-quart two-cylinder Club Aluminum Products Co. "homogenizer" and once through their 12 oz. "homogenizer." Microscopic examination showed a fairly normal fat globule size although there were some globules considerably larger than found in normal milk.

TABLE 4

Curd tension of "remade" milks (whole, skim milk and buttermilk) involving the use of a synthetic cream made by emulsifying butterfat in the buttermilk from churned washed cream

PRODUCT TESTED	CURD TENSION ¹	
	1ST TEST	2ND TEST 24 HOURS LATER
	<i>grams</i>	<i>grams</i>
Original skim milk	78	67
Original buttermilk	41	
"Remade" whole milk	58	61
"Remade" skim milk	79	77
"Remade" buttermilk ²	43	45

¹ Using rennet extract as coagulant.

² pH 6.22.

the experiment cannot be offered as proof that no denaturing of the natural "membrane" occurs during churning it is very evident that any denaturization which does occur is insufficient to seriously affect its emulsifying properties and apparently has no effect on the influence the complex exerts on curd tension.

Effect on curd tension of "membrane" adsorbed by fat globules emulsified in skim milk.—The foregoing experiment suggested the possibility of determining whether butterfat globules will adsorb any material from skim milk which, when released during churning, will lower the curd tension of the "buttermilk." Two experiments were carried out employing the same general procedure as in the preceding experiment. For comparative purposes samples were saved of original whole milk, its skim milk fraction and buttermilk from churning a portion of the original cream. Melted, filtered butterfat was emulsified in another portion of the skim milk to form a cream, this was diluted with the skim milk to the fat content of normal whole milk, the latter re-separated and the cream churned, samples of the "remade" whole milk, skim milk and buttermilk being saved for curd tension tests.

The two experiments differed chiefly in that only one emulsification was employed in making the synthetic skim-milk cream in the first trial whereas the fat and skim milk mixture were put through the hand "homogenizer" four times in the second trial; also samples of original whole milk, skim milk and buttermilk were not saved for curd tension tests in the second trial. The composition of the products made in the two experiments was as follows:

	1st trial	2nd trial	
	Fat	Fat	Solids-not-fat
	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>
"Remade" cream	29.5	33.0	
"Remade" whole milk	4.4	4.2	
"Remade" skim milk		0.15	9.05
"Remade" buttermilk		1.50	9.40

Previous experience in this laboratory has shown that dilute emulsions made from butterfat and skim milk do not separate as readily as normal milk and the cream thus obtained churns with difficulty, showing large losses of fat. These difficulties were experienced in the present trials. The churning time for the cream in the first trial was 3 hours and for the second trial 1 hr. 10 min.

The curd tension data are shown in Table 5. The results of the two experiments are in harmony in showing that buttermilk produced in the

TABLE 5

Curd tension of "remade" milk (whole, skim milk and buttermilk) involving the use of a synthetic cream made by emulsifying butterfat in skim milk

PRODUCT TESTED	CURD TENSION ¹	
	1ST EXP	2ND EXP
	grams	grams
Original whole milk	45	
Original skim milk	57	
Original buttermilk	31	
"Remade" whole milk	56	72
"Remade" skim milk	59	74
"Remade" buttermilk	58	94

¹ Rennet extract used for coagulant.

churning of cream synthesized from butterfat and skim milk has the same or even higher curd tension as the skim milk. It is unfortunate that the fat content of the "remade" buttermilk was not determined in experiment 1; it may have been much greater than for experiment 2 in which there is evidence that the plasma solids adsorbed by butterfat from skim milk are those which tend to cause higher curd tension. The curd strength of this buttermilk was surprisingly high in view of the high fat content.

These results furnish further evidence of the rôle of the natural fat globule "membrane" complex in the decreased curd tension of natural buttermilk. They also serve to substantiate the fact that milk plasma does not furnish the constituents which stabilize the natural milk emulsion.

Effect on curd tension of "membrane" adsorbed by fat globules emulsified in whey.—Rimpila and Palmer (9) have found that the composition of the adsorption "membrane" around the fat globules of an artificial cream made by emulsifying butterfat in whey is different from that of an analogous skim-milk cream; the proportion of protein per 100 grams of fat

is essentially the same being 650 mgm. for the skim-milk cream and 570 mgm. for the whey cream but the whey cream contains relatively much more phospholipide, as estimated from the lipide P per 100 grams of fat, i.e., 0.66 mgm. in contrast to 0.14 mgm. for the skim-milk cream. (These comparisons are based on creams washed three to four times). Natural creams, after analogous treatment, contain on the average approximately 620 mgm. protein and 10 mgms. lipide P per 100 grams fat.

Three experiments were conducted to test the effect on curd tension of the adsorption "membrane" released into skim milk from the emulsion formed by dispersing butterfat in fresh, sweet rennet whey. The procedure employed in preparing the products differed slightly in the three trials but it will be sufficient to describe the first trial and point out how the other two differed from it.

Whey was prepared from fresh skim milk by adding 2.5 ml., 1 to 50 dilution of Hansen's rennet extract to 1600 ml. milk, at 35° C. The time of clotting was 30 minutes. The whey removed equaled 1140 ml. Artificial cream was prepared by emulsifying 400 ml. melted butterfat with this volume of whey at 37° C., passing the mixture 4 times through the 2-quart Club Aluminum Co. hand "homogenizer." This cream was washed immediately with 4 volumes of water yielding 820 ml. of washed cream. This was diluted to a "remade" whole milk of 5,466 ml. using the original skim milk. This milk was separated to yield the "remade" skim milk and a "remade" cream, containing 30 per cent fat. The latter was allowed to stand over night at 5° C., brought to churning temperature and churned to yield the "remade" buttermilk. Churning required 1 hr. 20 min. The procedure in the second trial differed in the following details: The fat-whey mixture was passed through the "homogenizer" 5 times; the cream was allowed to stand 3.5 hours at 5°-10° C. before washing; the washing consisted of a single washing with 4 volumes of water, followed by a washing with 4 volumes of skim milk before being diluted with the skim milk to make the "remade" whole milk. In the third trial the emulsification was carried out 4 times and the washing with water and skim milk followed immediately. The "remade" cream, containing only 23.5 per cent fat, required 2 hrs., 20 min. to churn.

The results of the whey-cream experiments are shown in Table 6. It is evident that butterfat globules adsorb substances from whey which exert the same effect on curd tension as the natural fat globules "membrane" materials. In the second trial the curd tension reduction was much greater than observed in any of the "natural" membrane experiments. The explanation of this must await further study. This trial differed from the others only in that the first synthetic cream was allowed to stand for several hours at low temperature before it was washed. The low curd tensions of

TABLE 6

Curd tension of "remade" milk (whole, skim milk and buttermilk) involving the use of a synthetic cream made by emulsifying butterfat in whey

EXPERIMENT	PRODUCT TESTED	(CURD TENSION) ¹	FAT	TOTAL SOLIDS	SOLIDS-NOT FAT
		<i>grams</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>
1	"Remade" whole milk	63	3.80		
	"Remade" skim milk	74	0.06	8.46	8.40
	"Remade" buttermilk	52	0.40	8.87	8.44
	Original skim milk	85			
2	"Remade" whole milk	64			
	"Remade" skim milk	72	0.06	8.76	8.70
	"Remade" buttermilk	10	> 0.50	9.42	
	Original skim milk	77	0.06	9.27	9.21
3	"Remade" whole milk	65	3.50		
	"Remade" skim milk	77	0.06	9.50	9.44
	"Remade" buttermilk ²	44	0.70	9.72	9.02

¹ Using rennet extract as coagulant.

² pH of this buttermilk 6.24.

these "remade" buttermilks are clearly not related either to their gross composition or to their acidity.

DISCUSSION

The curd tension of natural buttermilk from sweet cream is approximately 70 per cent of that of the corresponding whole milk and about 50 per cent of that of the corresponding skim milk. Although this reduced curd tension is in line with Lundstedt's general observation we obtained no values as low as 7 grams, which Lundstedt reported. Contrary to Lundstedt's claims no effect on curd tension appears to follow the agitation of whole milk at low temperature. Either some other unrecognized factors entered into his experiments or his results were fortuitous. Lundstedt's hypothesis explaining the reduced curd tension of buttermilk (and agitated whole milk) as due to the adsorption by casein of lecithin released from the fat globule during churning is not substantiated by dispersing pure phospholipides in milk in concentrations equal to or greater than the lecithin content of buttermilk and further by providing the conditions for its maximum adsorption by the colloidal caseinate, namely mechanical emulsification at body temperature, agitation at low temperature and aging at low temperature.

The question may arise in the minds of some as to the validity of employing for these studies a phospholipide isolated from egg yolk. It may be stated in explanation that there are as yet no grounds for believing that lecithin from one source differs essentially in colloidal properties from lecithin from another source, although differences in chemical constitution

are not only probable but are to be expected. Our primary concern in this phase of the study was to employ pure phospholipide, unoxidized and uncontaminated with the impurities which abound in the so-called lecithin preparations from eggs and soybeans employed in technical dairy product manufacturing operations.

The criticism might also be advanced that the lecithin which we employed was contaminated with 15-20 per cent cephalin. This criticism is invalidated by the recent finding of Spiegel-Adolph (10) that cephalin is much more readily adsorbed by colloidal gold, protein and cholesterol than is lecithin. Our phospholipide may therefore be regarded as probably being a "stronger" colloid than if it had actually been pure lecithin.

Lundstedt's hypothesis somewhat approaches the correct explanation, however, in that it is definitely demonstrated that the natural phospholipide-protein complex on the fat globule surfaces which is released during churning, is responsible for the reduced curd tension of buttermilk. Artificial buttermilks prepared by the direct addition to milk of a concentrated sol of this complex, and "buttermilks" obtained by churning "remade" creams formed by diluting washed cream with skim milk and reseparator, exhibit curd tensions as low as those of natural buttermilk. Even when the cream is more artificial, namely, is made by emulsifying butterfat in the buttermilk from washed cream, and then dispersing this cream in normal milk plasma, the final "buttermilk" likewise shows a low curd tension. On the other hand synthetic creams involving only butterfat and skim milk produce "buttermilks" having curd tensions equal to or greater than the skim milk.

A peculiar appearance and a decided non-foaming tendency characterized all the buttermilks and also the whey from the curd tension tests whenever the natural fat globule membrane complex was present. These wheys especially have a characteristic brownish tint not seen in whey from skim milk. Moreover, concentrated sols of the membrane complex have a similar tan color. This color is not evident in the curd-test wheys from the artificial products involving butterfat emulsions in skim milk and in whey.

The reduced curd tension of the "buttermilk" obtained from the emulsions in rennet whey was unexpected. It is apparent that the phospholipide complex adsorbed from whey by the butterfat globule surfaces reduces the curd tension of milk plasma in the same manner as the natural fat globule membrane. However, the fact that this complex contains only about 7 per cent as much phospholipide as the natural "membrane" complex, according to the data of Rimpila and Palmer (9) seems to point to the protein of the complex as the major curd tension reducing agent. This aspect of the problem, as well as the explanation of how this small amount of foreign

material exerts such a marked effect on curd tension are being investigated further. The authors wish to reserve this problem for study.

CONCLUSIONS

The relatively low curd tension of fresh sweet-cream buttermilk is not explained by the release of lecithin from the fat globule surfaces during churning. Instead, it is the release of the fat globule "membrane" complex which is the factor involved. The exact cause of the lowered curd tension when this material is added to milk remains to be discovered.

Agitation of whole milk at temperatures below that of churning does not cause the milk to have a reduced curd tension.

Butterfat globules do not adsorb any substances from skim milk which reduce the curd tension of milk plasma.

Butterfat globules adsorb some complex from normal rennet whey which reduces the curd tension of milk plasma. The relatively low phospholipide content of the adsorption "membrane" complex of whey-cream suggests that the protein component is the major one concerned in its effect on curd tension. This may also be the case for the natural fat globule "membrane."

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DETECTING RECONTAMINATION OF PASTEURIZED MILK BY BACTERIOLOGICAL METHODS*

W. H. CHILSON,¹ M. W. YALE,² AND R. EGLINTON³

New York State Agricultural Experiment Station, Geneva, New York

INTRODUCTION

The primary objects of pasteurization of milk are to (1) destroy any pathogenic organisms which may be present and (2) prolong keeping quality. These aims are defeated if recontamination occurs following pasteurization. Therefore, methods which will detect recontamination are important for workers entrusted with maintaining the quality of pasteurized supplies.

Plant inspections may not disclose sources of recontamination since they may be made at a time when faulty conditions are not apparent. Also, a routine examination of street samples by means of standard agar plate counts is of little value in this respect since there is no way of determining whether or not high bacterial counts are due to recontamination or other conditions.

An examination of a series of plant samples taken at various points of processing is valuable in detecting recontamination particularly if the first milk passing over the equipment is sampled. Recently, there has been a tendency to supplement the standard agar plate count with a count of organisms of the colon group. Among the reports on this subject should be mentioned the work of McCrady and Langevin (1). They found that the presence of organisms of the colon group in pasteurized milk sometimes reveals sources of contamination that standard agar plate counts do not show since a relatively small increase in the number of colon organisms could be detected while no appreciable change was apparent in the standard plate count. By means of the test for colon organisms, they were able in one instance to detect a potentially dangerous source of contamination that plant inspection did not reveal.

In the present study, a routine monthly examination of process samples taken at two plants indicated post-pasteurization contamination in the case of one plant. The success in locating sources of recontamination and in correcting faulty conditions was such that the results obtained should be of interest to workers in this field.

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¹ Student Assistant.

² Associate in Research.

³ Milk Inspector and City Bacteriologist, Geneva, New York.

METHODS

The number of colon organisms per cc was estimated by means of plate counts from a lactose desoxycholate agar (2) of the following composition:

Agar	15 grams
Proteose peptone	10 "
Sodium desoxycholate*	1 gram
Sodium chloride	5 grams
Dipotassium phosphate	2 "
Lactose	10 "
Ferric ammonium citrate (green scales)	2 "
Distilled water	1000 cc
pH	7.4

The agar was placed in flasks in 200 cc amounts and partially sterilized by flowing steam for 30 minutes. Absolute sterilization by steam under pressure is not necessary in the case of this medium since spore-forming rods will not grow. One cc and one-tenth cc quantities of milk were plated with 12 to 15 cc of the above medium, poured before the milk dried to the plate. After solidification, about 3 cc of agar were poured over the surface to secure entirely subsurface colonies as earlier work had shown that this facilitated identification of colon colonies. Plates were incubated 20 to 24 hours at 37° C. and the deep red colon colonies counted. One colony of each type was usually transferred to lactose broth and tubes showing gas were streaked on eosine methylene blue agar for partial confirmation. In the case of the plants studied, deep red colonies on the plates from pasteurized milk always confirmed as colon colonies.

RESULTS OBTAINED.

Both plants had pasteurizing runs of about three hours. Plant A employed the Electropure system of high-temperature, short-time pasteurization using a pasteurizing temperature of 162°–163° F. and a holding time of 15–20 seconds. Plant B employed three Pfaudler glass-lined pasteurizers using a pasteurizing temperature of 143°–144° F. for 30–40 minutes. The customary procedure was to preheat the raw milk entering the pasteurizer to 110°–130° F. and to then raise the temperature to 143° in the vat.

A series of process samples were taken at the start, middle and end of the run at plant A and from four different batches at plant B. Samples of pasteurized milk were taken at four points between the pasteurizer and the bottler in the case of each series at plant A and the first series at plant B. Subsequent series of samples at plant B were taken from only the raw and the freshly pasteurized milk. The presence or absence of organisms of the colon group in 1 cc quantities of milk is shown in Table 1. Organisms of the colon group were present in 1 cc quantities of raw milk in 63 samples out

* Obtained from Biedel-de Haen, Inc., 105 Hudson St., New York.

of 68 in numbers ranging between 1 per cc and 13,000 per cc. During the winter months, the number of organisms of the colon group was usually less than 100 per cc.

Colon organisms were not found in 1 cc amounts of freshly pasteurized milk in any of the 77 instances (includes 30 samples taken at cooler inlet at plant A since the holding time takes place as the milk flows between the Electropure unit and the cooler). This shows that colon organisms failed to survive pasteurization temperatures. At plant A, positive results were not obtained from samples taken at the cooler outlet, bottler bowl or of the first milk over the cooler indicating that there was no recontamination of the pasteurized milk.

TABLE 1

Presence of organisms of the colon group in 271 samples of raw and pasteurized milk taken monthly for one year at two plants

PLANT	PRESENCE OR ABSENCE OF LARGE RED COLON COLONIES ON PLATES FROM 1 CC QUANTITIES OF MILK											
	Raw milk		Pasteurized milk									
	Supply tank		Pasteurizer		Cooler inlet		Cooler outlet		Bottler bowl		First milk over equipment*	
	+	-	+	-	+	-	+	-	+	-	+	-
A	30	0	**	**	0	30	0	30	0	30	0	30
B	33	5	0	47	2	10	**	**	5	7	8	4

* Represents the first can of milk drawn off between the cooler and bottler bowl at plant A and from the bottler bowl at plant B.

** No samples taken.

The practice of pumping hot water through the line for 5 minutes at 180° F. just prior to pasteurization evidently caused the destruction of any colon organisms present on the equipment.

Recontamination of pasteurized milk took place at plant B as evidenced by presence of organisms of the colon group in some of the samples taken at the cooler inlet, from the bottler bowl and of the first milk over the equipment. More positive results were obtained in the case of the first milk over the equipment (8 out of 12) than in the case of the samples from the cooler inlet (2 out of 12) or from the bottler bowl (5 out of 12) indicating that the equipment was contaminated.

There is no object in testing for the presence of organisms of the colon group if the standard plate count will detect recontamination just as readily. Comparative standard agar plate counts and plate counts of colon organisms for the first series of samples taken at plant B are shown in Table 2. Counts of raw and preheated milk are omitted since they are not of interest in connection with this problem.

Standard agar and colon counts of the first milk over the equipment were usually higher than those of milk sampled later from the cooler inlet and from the bottler bowl (Table 2). In 8 of the 12 monthly tests, colon organ-

TABLE 2
*Comparative standard agar plate counts and plate counts of colon organisms per cc.
Obtained from monthly processing samples at Plant B*

DATE 1934-35	SOURCE OF SAMPLE							
	Pasteurizer		Cooler inlet		Bottler bowl		First over equipment	
	Total count	Colon count	Total count	Colon count	Total count	Colon count	Total count	Colon count
October	4100	<1	4900	1	4300	2	44000	78
November	2000	<1	3200	9	1800	32	1500	23
December	3500	<1	3900	<1	2500	<1	3300	<1
January	5800	<1	4700	<1	6000	<1	19000	13
February	4800	<1	7500	<1	3900	<1	3000	<1
March	4700	<1	4800	<1	5400	13	8600	<1
April	4700	<1	3100	<1	5200	<1	53000	<1
May	4200	<1	2800	<1	3200	<1	7200	50
July	300	<1	3600	<1	13000	4	54000	3
August	14500	<1	16000	<1	12000	<1	83000	3000
September	10800	<1	8000	<1	7500	<1	4300	340
October	2800	<1	29000	<1	2000	3	6000	11

isms were present in the first milk over the equipment. In 4 of the 8 instances, (Oct., Jan., July, Aug.) there was also an appreciable increase in the standard agar plate count indicating that recontamination could be detected as readily by one method as by the other. In the 4 remaining instances out of the 8 (Nov., May, Sept., and Oct.) differences in standard plate counts were too slight to be of significance while the presence of colon organisms in numbers ranging between 11 and 340 per cc in the first milk over the equipment definitely indicated recontamination. In one instance (April), out of the four in which colon organisms were not found, the standard plate count increased from 4700 per cc in the freshly pasteurized milk to 53,000 per cc in the first milk through the equipment indicating recontamination. In this case, recontamination was not detected by the test for colon organisms. This supports the viewpoint of McCrady and Langvin that the test for colon organisms should not supplant but should be used in conjunction with the total count.

Since colon organisms were always absent from 1 cc quantities of the freshly pasteurized milk, it was evident that when recontamination occurred it took place between the pasteurizer and bottler. Ninety-two samples were taken between these points to determine the sources of recontamination (Table 3).

Numbers of colon organisms in the first milk over the equipment varied

TABLE 3
Plate counts per cc of organisms of the colon group obtained from 92 samples of pasteurized milk taken at Plant B in studies of sources of recontamination

DATE 1935	SOURCE OF SAMPLE								
	Pasteur- izer	Outlet valve	Pump	Cooler inlet	Cooler outlet	Bottler bowl	Freshly bottled milk	First milk over equipment	Drippings from coupling into bottler
October 2	<1	<1	100	<1	<1	<1	1	40	
October 3	<1	<1	<1	<1	<1	20	10	10	
October 4	<1	150	140	10	10	<1	<1	290	
October 10	<1	7	20	2	10	20	13	160	2600
October 11	<1	240	620	60	30	140	70	1250	
October 15	<1	<1	<1	<1	<1	2	1	1	5000
October 16*	<1	<1	<1	<1	<1	3	1	11	1280
October 17	<1	<1	<1	<1	<1	<1	<1	<1	
October 18	<1	<1	<1	<1	<1	<1	<1	<1	
October 21	<1	<1	<1	<1	<1	<1	1	<1	
October 22	<1	<1	<1	<1	<1	<1	4	<1	
November 1								<1	

* Sources of recontamination and proper sterilization of equipment discussed with plant employees.

between 1 and 1,250 per cc during the period between October 2 and 16 when no effort was made to correct faulty conditions. The pump was the major source of recontamination on October 2, the bottler on October 3 and the outlet valve on October 4, 10 and 11. On October 15 and 16, a few colon organisms were recovered from the milk sampled in the bottler bowl, indicating again that this was a source of recontamination. These results indicated several sources of recontamination.

Observations of plant operations showed that recontamination from the outlet valve was probably due to occasional neglect to steam the milk line leading from the outlet valve before the pasteurized milk was drawn from the vat. A slight amount of partially pasteurized milk ordinarily dripped into the outlet line and ran onto the floor if the cap was left off the end of the line. The operator was instructed by the local inspector to remove this cap and sterilize the line with steam before the outlet valve was opened but was careless in this respect.

In the case of the pump, recontamination with organisms of the colon group was undoubtedly due to growth following improper cleaning and sterilization.

Recontamination from the bottler which was slight as indicated by colon counts ranging between 2 and 20 per cc on October 3, 15 and 16, was due to a mixture of condensation water and pasteurized milk which sometimes dripped into the bottler bowl from a loose coupling in the sanitary line. This coupling contained arms several inches in length to make it possible for the men working at the bottle-filler to adjust by hand the height of the float valve when changing the size of bottles. The milk which leaked from the coupling dripped from the ends of the arms. Two covers were provided for the bottler bowl but were sometimes removed and offered only partial protection against leakage when used. Three samples of the mixture of milk and water which dripped from this coupling yielded colon counts of 2,600; 5,000 and 1,280 per cc respectively.

While recontamination from this source was not great as possibly only one or two drops of the mixture entered a bottle of milk, it was potentially dangerous due to the possibility of contamination with pathogens from human sources. The danger of this sort of recontamination, though slight, must be recognized since records obtained from the United States Public Health Service (3) show that 3 out of 11 disease outbreaks occurring in pasteurized supplies during the past 5 years were typhoid fever outbreaks that were traced to typhoid carriers who operated either bottling machines or handled bottles.

The sources of recontamination with colon organisms and their significance were called to the attention of the plant manager. On October 16, a meeting was held with plant employees at which instructions were given in regard to the care and sterilization of equipment. Subsequently, all sani-

tary fittings and piping were boiled daily for 10 minutes and remaining equipment thoroughly sterilized. A new single piece cover was provided for the bottler which adequately protected against recontamination from the source previously discussed. As an additional safeguard, a chlorine solution was provided for sterilization of hands of employees working on the bottling machine. The operator in charge of the pasteurizer steamed the outlet line thoroughly before the outlet valve was opened.

The effectiveness of these changes is shown by the fact that subsequently (October 17–November 1) colon organisms were recovered in the case of only 2 out of 33 samples and then in only small numbers (1 per cc and 4 per cc). If the present methods are continued, the bottled pasteurized milk from this plant should remain free from colon organisms in 1 cc quantities.

SUMMARY AND CONCLUSIONS

A study of 271 samples of raw and pasteurized milk collected over a one-year period at two pasturizing plants by means of standard agar plate counts and plate counts of colon organisms showed that the pasteurized milk from one plant was frequently recontaminated before it was bottled. While recontamination was usually indicated by both standard agar plate counts and counts of colon organisms, there were instances in which one or the other of the two methods indicated recontamination when the other method did not. Therefore, the test for organisms of the colon group should supplement and not supplant the standard agar plate count.

Sources of recontamination as indicated by counts of colon organisms from 92 special samples were (1) failure to steam milk lines leading from outlet valves of batch pasteurizers (2) improper cleaning and sterilization of the milk pump, and (3) leakage of milk and water from a sanitary connection contaminated by human sources into the bowl of the bottler. The latter source was potentially dangerous.

Properly pasteurized milk free from recontamination did not contain colon organisms in 1 cc quantities.

REFERENCES

- (1) McCrady, M. H., and Langevin, E. *JOURNAL OF DAIRY SCIENCE* 15: 321. 1932.
- (2) LEIFSON, EINAR. *Jour. Path. and Bact.* 40: 581. 1935. Also personal correspondence, 1934.
- (3) U. S. Public Health Service, Office of Milk Investigations. Milk-borne outbreaks reported by state and city health officers as occurring in the United States in 1929–1934. Mimeographed reports E-875, H-875, B-460, B-466a. Also personal correspondence.

American Dairy Science Association Announcements

THIRTY-FIRST ANNUAL MEETING, JUNE 16-19, 1936
STATE COLLEGE, PENNSYLVANIA

HOUSING PLANS

The college dormitories will be available to those attending the meeting at 75¢ a night with two or more people in a room, or \$1.00 a night, one person in a room. Extra cots will be provided for children. The rate for children will be the same as for adults. The dormitory buildings are new, and the rooms are large, airy, and well equipped. The Committee on Housing is doing everything possible to make everyone comfortable while here.

If you wish to bring the family, several cottages on the campus will be available. These cottages hold from twelve to fourteen persons and have two or three separate bathrooms. In all dormitories and cottages it will be necessary for you to furnish your own *towels* and *soap*. Tourist cabin accommodations are not available in the vicinity of State College. A large number of very good tourist homes are available, however, in the town of State College which is adjacent the campus.

Members desiring to stop at hotels may make their own reservations at The State College Hotel, corner of College Avenue and Allen Street; rates, \$1.50 to \$3.00 single and \$3.00 to \$6.00 double. The Penn State Hotel is also conveniently located at 310 East College Avenue; rates, \$1.50 single and \$2.50 double.

All reservations and further information on housing should be obtained from the Chairman of the Housing and Registration Committee, Doctor M. A. Farrell, Department of Bacteriology, State College, Pennsylvania.

A golf tournament is being planned for members. Anyone interested should make their wishes known to Professor R. H. Olmstead, Chairman of Committee, for this event, Department of Dairy Extension, State College, Pennsylvania.

Optional tours starting at 2 P.M. on Friday, June 19, were announced in the April issue of the JOURNAL. Members planning on the trip to the Dairy Bureau Laboratories and the farm at Beltsville, Maryland, at the close of the meetings should get in touch with the Chief of the Bureau of Dairy Industry, Mr. O. E. Reed, Department of Agriculture, Washington, D. C. Members of the Dairy Bureau are planning to entertain Dairy Science visitors at Washington and Beltsville on Saturday morning, June 20, at 9:00 o'clock.

PROGRAM FOR LADIES, YOUNG PEOPLE AND CHILDREN

JUNE 16—TUESDAY

- 8:30 P.M. Informal social get-together for members and their families, Second Floor Lounge, New "Old Main Building."

JUNE 17—WEDNESDAY

- 9 A.M.—4 P.M. Mountain tour for ladies, young folks and children of members. Standard buses will provide safety and comfort. See the laurel in bloom in the beautiful Seven Mountains, and visit Alexander Caverns. Luncheon at Greenwood Furnace, one of the real beauty spots. Complimentary tickets covering the whole trip at registration.

JUNE 18—THURSDAY

- 9 A.M.—12 noon For young folks and children. Supervised play, municipal playground or mountain hike for those who prefer it.
- 10 A.M.—12 noon For ladies. Rest or see places of interest on campus. Old Main Tower, Home Economics Building, Mineral Industries Exhibits and Rose Gardens adjacent the dairy building. Not an organized tour. Golf for those who prefer it.
- 2 P.M.—4 P.M. For children and young folks. Swimming at the Glennland Pool, finest in Pennsylvania. Bring your bathing suits along. Mothers included if they so desire. Exclusive use of pool reserved. Complimentary tickets at registration.
- 2 P.M.—4 P.M. Entertainment for ladies at the Nittany Lion Inn. Favors by courtesy of cooperating commercial organizations.

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THE QUANTITIES OF GRASS THAT DAIRY COWS WILL GRAZE

T. E. WOODWARD

*Division of Dairy Cattle Breeding, Feeding, and Management, Bureau of Dairy
Industry, U. S. Department of Agriculture, Washington, D. C.*

In order to determine how much, if any, supplementary feed should be fed to dairy cows on pasture it is important to know how much grass they will likely graze and the quantity of nutrients they will obtain from the grass.

Observations by the Bureau of Dairy Industry at Beltsville, Md., over a period of years showed that, with the system of feeding practiced there, cows decline rapidly in milk flow early in the summer while the grass is still fairly abundant; also that cows producing 1 pound of butterfat or less a day on pasture apparently maintain their production and body weight for a short time in the spring as well without grain feeding as with grain feeding.

In an investigation (1) at the Bureau's field station at Huntley, Mont., four Holstein-Friesian cows were fed grass clipped from irrigated pastures, for periods of 15 to 55 days. The average daily consumption by individual cows for an entire period varied from 122 pounds for the smallest cow to 152 pounds for the largest cow. The maintenance of milk flow and body weight indicated that these cows consumed enough grass to support a milk production of 37 pounds a day.

While one might be justified in assuming that cows will graze as much grass as they will eat out of a manger, provided the grass is sufficiently tender and abundant so they can gather their fill with little effort, it seemed that the truth of this assumption could be determined only by actual grazing trials.

The investigation reported in this paper, therefore, was undertaken to find out how much grass cows would graze, when grass was present in various degrees of abundance, both when the weather was cool and when it was warm. With this information it was hoped that a satisfactory explanation would be found for the behavior of cows on pasture and that a foundation could be laid for a better feeding system.

Received for publication January 18, 1936.

PLAN OF THE INVESTIGATION

The method of arriving at the quantity of grass cows will graze was to pasture cows on a certain area of grass for a given time. The cows were then removed and the remaining grass was clipped as low or lower than that where the cows had grazed. At the same time an area of similar pasturage which had not been grazed was clipped, and the difference between the quantities of clipped grass from the two areas was considered equivalent to the quantity of grass the cows obtained by grazing.

Twelve grazing trials were made in 1932, and three in 1933. Two cows grazed in each trial, from 2 to 4 days. Both Jersey cows and Holstein-Friesian cows were used.

It was considered important that the trials be made under normal grazing conditions, as nearly as possible. For that reason the cows were confined on the areas to be grazed, by fences instead of by tethering them. Two cows were placed on the same area because it was believed that two cows together would be more contented than one cow by herself. Good producing, vigorous cows were used since it was desired to have individuals that had both a demand for a large quantity of grass and an ability to graze a large quantity.

The pasture in which the trials were made was bounded on two sides by parallel fences 314 feet apart. Temporary fences were run from one side of this pasture to the other to enclose the strips to be grazed, also strips to be kept ungrazed. The grazed strips varied in size from 0.30 to 0.58 acre; the ungrazed strip alongside was usually 0.15 acre.

In order that the cows might start each grazing trial with a normal fill, they were kept for 2 days preceding each trial (in the same field as the fenced-off area) on grass similar to that to be grazed. No grain or other feed was given to the cows, either during the 2-day preliminary period or while they were grazing in the trial.

Water was provided in the pasture but no shade of any kind. During each trial the cows were on the grazing plot day and night and were taken off only long enough to be milked. After the cows had grazed in each trial the allotted time, 2 to 4 days, the fences were removed and each plot was clipped separately.

The original plan was to use a power lawn mower to clip these plots, and to facilitate the mowing the ground was smoothed with a roller early in the spring. It was found, however, that a farm mower could be used (by removing the shoes and setting it to cut as low as possible) to clip the grass fully as short as the cows had grazed. The clippings were collected in a galvanized-iron pan attached to the rear of the cutter bar.

The grass clipped from each plot was weighed separately and analyzed for feed nutrients. The difference between the amount of nutrients from

the ungrazed and the grazed areas represented the nutrients consumed. Digestion coefficients applied to these amounts indicated the digestible nutrients consumed. The coefficients used were the averages between those obtained by feeding green grass to dairy cows at the Pennsylvania, Vermont, and Beltsville, Md., Stations (3). These coefficients were 73.9 for crude protein, 53.6 for ether extract, 76.6 for nitrogen-free extract, and 73.7 for crude fiber.

COWS USED

Six of the 12 trials in 1932 were with Holstein cows, and 6 were with Jersey cows. Of the 3 trials in 1933, 1 was with Jerseys and 2 were with Holsteins.

In the 1932 trials with Holsteins, the same two cows were used throughout the season, one being a grade cow and the other a registered cow. The first trial was from May 22 to May 24. The grade cow had calved March 18, and the registered cow April 23, 1932. Previous to the first trial the grade cow had been on pasture since April 16 and the registered cow since April 28. The grade cow was also getting 8 to 12 pounds of grain a day and the registered cow 6 to 10 pounds. Between trials during the rest of the season these two cows were each fed 10 to 12 pounds of grain a day. The object of the grain feeding was to maintain the production so that when these cows were put on the experimental grazing plots they would have a demand for a large quantity of grass. By keeping up the production of these two cows it was not necessary to make any replacements.

In the 1933 Holstein trials, two grade cows were used in the first trial, April 24-27. One of these had calved September 8, 1932, the other February 18, 1933. Both had been on pasture since April 16 and had been getting 5 to 7 pounds of grain a day. In the next trial, July 8-12, a grade cow and a registered cow were used. They had calved June 12 and June 18, respectively, and had been fed 10 to 12 pounds of grain a day immediately prior to the trial.

In all trials with Jersey cows, only registered cows were used. In 1932, one of the cows used in the May trials had calved March 7, the other April 21. One had been on pasture since April 19, the other since April 27. Neither had received any grain since May 1.

One of these cows was disposed of after the May trials, and her place was taken by another Jersey for the rest of the 1932 trials. This cow had calved March 4, 1932. The Jersey cows were fed from 10 to 16 pounds of grain while on pasture between trials.

One of the Jersey cows in the trial of April 24-27, 1933, had been used in all 1932 trials. She had calved again January 30, 1933, and had been fed 2 to 6 pounds of grain from the time she was turned on pasture, April 16. The other cow had calved November 29, 1932, and had received 4 to 5

TABLE 1
Composition of the green grass clipped from the different grazed and ungrazed plots, and the breed used in the grazing trial

DATE CLIPPED	BREED USED IN TRIAL	PLOT	DRY MATTER	DRY MATTER BASIS						Phosphorus
				Protein	Ether extract	Ash	Nitrogen- free extract	Crude fiber	Calcium	
			Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
1932										
5-18	Jer.	Grazed	19.6	19.9	4.5	10.8	38.3	26.6	0.67	0.41
5-18		Ungrazed	18.2	22.4	4.9	11.2	37.8	23.7	0.73	0.44
5-20	Jer.	Grazed	21.8	15.9	4.2	9.9	41.7	28.3	0.66	0.41
5-20		Ungrazed	19.6	18.8	5.0	10.0	40.8	25.4	0.64	0.42
5-24	Hol.	Grazed	22.7	14.2	3.9	9.2	43.7	28.9	0.53	0.38
5-24		Ungrazed	20.7	17.0	4.8	9.8	43.8	24.7	0.70	0.39
5-26	Hol.	Grazed	23.2	14.8	4.3	10.3	40.2	30.4	0.60	0.44
5-26		Ungrazed	21.9	15.5	4.5	9.2	43.1	27.7	0.72	0.38
6-24	Jer.	Grazed	24.5	18.9	4.7	9.7	40.2	26.5	0.82	0.48
6-24		Ungrazed	22.7	20.8	4.5	9.8	38.8	26.1	0.76	0.48
6-24	Hol.	Grazed	23.2	19.1	3.7	10.0	39.7	27.5	0.80	0.48
6-29	Jer.	Grazed	25.5	17.4	4.0	9.7	40.1	28.7	0.76	0.51
6-29		Ungrazed	23.2	20.0	4.9	10.1	38.2	26.8	0.66	0.49
6-29	Hol.	Grazed	24.9	17.2	3.9	9.7	40.0	29.3	0.79	0.46
8-16	Jer.	Grazed	38.0	14.8	5.1	8.9	45.5	25.7	0.95	0.40
8-16		Ungrazed	39.8	17.2	5.4	7.5	46.3	23.6	1.14	0.36
8-16	Hol.	Grazed	44.5	14.1	4.4	8.4	48.0	25.2	1.13	0.34
8-19	Jer.	Grazed	35.0	14.3	5.0	8.6	45.5	26.6	0.96	0.35
8-19		Ungrazed	29.0	15.0	5.0	8.9	45.4	25.7	0.78	0.38
8-19	Hol.	Grazed	29.5	14.8	4.3	9.0	44.5	27.4	0.87	0.35
1933										
4-27	Jer.	Grazed	23.3							
4-27		Ungrazed	23.0							
4-27	Hol.	Grazed	23.2							
7-12	Hol.	Grazed	27.3							
7-12		Ungrazed	25.4							

TABLE 2
The quantities of grass and of nutrients consumed by grazing—average per cow per day¹

DATES	BREED	GREEN WEIGHT OF GRASS	TOTAL DRY MATTER	NUTRIENTS IN DRY MATTER					
				Crude protein	Ether extract	Ash	Nitrogen-free extract	Crude fiber	Calcium
				Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
1932:									
May 16-18	Jer.	136	23.5	5.6	1.2	2.7	8.9	5.1	0.18
May 18-20	Jer.	167	31.6	6.2	1.8	3.2	12.8	7.7	0.20
May 22-24	Hol.	147	28.9	5.4	1.5	2.9	12.7	6.4	0.23
May 24-26	Hol.	152	31.9	5.1	1.4	2.7	14.5	8.2	0.11
June 22-24	Jer.	98	20.5	4.7	0.8	2.0	7.6	5.2	0.10
June 22-24	Hol.	32	6.5	2.0	0.6	0.5	2.2	1.1	0.10
June 26-29	Jer.	98	20.6	4.7	1.2	2.2	7.4	3.0	0.03
June 26-29	Hol.	109	23.9	5.4	1.4	2.5	8.7	3.8	0.11
Aug. 14-16	Jer.	34	14.2	2.7	0.8	0.9	6.6	3.1	0.12
Aug. 14-16	Hol.	50	19.5	3.5	1.1	1.4	8.9	4.5	0.05
Aug. 17-19	Jer.	61	15.2	2.4	0.8	1.4	6.8	3.7	0.22
Aug. 17-19	Hol.	50	14.3	2.2	0.8	1.2	6.6	3.4	0.09
1933:									
Apr. 24-27	Jer.	148	33.9						
Apr. 24-27	Hol.	154	35.3						
July 8-12	Hol.	146	34.1						

¹ In 1933 chemical analyses were made only for moisture.

TABLE 3

Average daily consumption of grass, dry matter, and total digestible nutrients per cow: the quantity of nutrients available for milk production in excess of the nutrients required for maintenance; and the quantity of milk production the excess nutrients would support

DATE OF TRIAL	DESCRIPTION OF PASTURAGE				AIR TEMPERATURE		BREED OF COWS	AVERAGE AGE OF COWS	AVERAGE PRODUCTION		AVERAGE DAILY CONSUMPTION PER COW		T.D.N. AVAILABLE FOR MILK PER COW PER DAY	MILK PRODUCTION PER COW PER DAY WHICH THE EXCESS NUTRIENTS WOULD SUPPORT																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
	Kind	Height	Herbage per acre		Maximum	Minimum			° F.	° F.	lbs.	Per cent			lbs.	lbs.																																																																																																																																																																																																																																																																																																																																																																																																																																																															
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																	Inches	lbs.	Per cent	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.

pounds of grain a day from the time she was turned on pasture, April 14, to the beginning of the trial.

RESULTS

The analyses¹ of the green grass from the different grazed and ungrazed plots are given in table 1.

The quantities of green material and of the nutrients consumed by the grazing cows are shown in table 2.

Table 3 contains a description of the pasturage, the cows and their production, and gives the maximum and minimum temperatures during the period of grazing; also a summary of the consumption of grass and nutrients, and an estimate of the quantities of milk for which the grass intake would provide the nutrients.

In May, 1932, when the grass was tender and abundant and the weather cool, Jersey cows in two trials ate an average of 151 pounds of green grass a day. The Holstein cows ate 149 pounds. This compared very well with the quantity consumed by cows at Huntley, Montana, when the grass was clipped and fed in the stable and is perhaps near the maximum quantity that cows will consume. The quantity of dry matter consumed by the Jerseys was 27.5 pounds per cow per day on an average, while that consumed by the Holsteins was 30.4 pounds. The grass grazed by the Holsteins had a little higher percentage of dry matter than that grazed by the Jerseys.

The Jerseys ate an average of 19.1 pounds of digestible nutrients; the Holsteins 21.4 pounds. Deducting for maintenance at the rate of 7.925 total digestible nutrients for each 1,000 pounds of live weight, it appears that the Jersey cows, although actually producing an average of about 28 pounds of milk a day, ate only enough to support a production of 26 pounds and the Holstein cows, producing 45 pounds a day, ate only enough for about 35 pounds. During this period the quantity of grass each of the cows ate in a day on the average was 5.8 per cent of that standing on one acre.

After these trials in May the pasture was heavily grazed and then clipped in order to have a uniform growth for further trials in June.

The quantity of grass on the ground in June was only a little more than half that in May. The Jersey cows ate 98 pounds of grass a day in each of two trials; the Holstein cows ate 32 pounds a day in one trial and 109 in the other. No explanation is offered for the low consumption by the Holsteins in the first trial. So far as known, there was no error in the methods or in calculation. However, the estimate is so much at variance with the other estimates of consumption by the cows during June that its omission from consideration appears justified. If this is done, the Jerseys ate an average of 20.5 pounds of dry matter a day and the Holsteins 23.9 pounds.

¹ All chemical analyses were made by Charles B. Parker, junior chemist, Bureau of Dairy Industry.

The quantity of digestible nutrients consumed per day was 13.5 pounds for the Jerseys and 15.1 pounds for the Holsteins. After deducting for maintenance, it appears that the Jerseys ate enough grass for about 15 pounds of milk a day, although they actually gave 25 pounds. The Holsteins ate enough for 13 pounds of milk and they actually gave 33 pounds. The average quantity of grass consumed daily by each cow was 6.9 per cent of that standing on one acre.

The trials were repeated in the same way in August when the growth of grass was still less than in June. The Jersey cows ate an average of 47 pounds of grass a day in two trials and the Holstein cows an average of 50 pounds. The quantity of dry matter consumed by the Jerseys was 14.7 pounds; by the Holsteins 16.9 pounds.

The digestible nutrients consumed by the Jerseys amounted to 10.5 pounds a day; by the Holsteins 12.1 pounds. Allowing for maintenance the Jerseys ate enough for 5 or 6 pounds of milk and actually produced about 22 pounds. The Holsteins ate enough for only 2 or 3 pounds and actually produced about 29 pounds. The quantity of grass consumed daily by each cow was 5.2 per cent of that standing on one acre.

The pasture was, of course, poorer in June than in May and still poorer in August; but even in August, it is believed, the pasture would have been rated fair to good; and it was probably better than the average run of pastures at that season of the year.

Late in April, 1933, the trials were again repeated with much the same result as in May, 1932. The grass was a little better than in the previous year. The Jersey cows ate 148 pounds of grass and the Holstein 154 pounds. The dry matter consumption was 33.7 and 35.2 pounds, respectively, and the consumption of digestible nutrients 23.3 and 24.3 pounds. Allowing for maintenance, this was enough for the production of 40 pounds of milk by the Jerseys and 45 pounds by the Holsteins. Actually the Jerseys gave 21 pounds and the Holsteins 34 pounds. The quantity of grass consumed daily per cow was 4.4 per cent of that standing on one acre.

Because of the unusually favorable season, the grass in July, 1933, was similar in composition to that in May. Although probably no taller than in May, 1932, or April, 1933, the grass was much thicker, which accounts for the higher yield per acre. Only Holstein cows were used in this last trial. They ate 146 pounds of grass per cow per day, or 34.1 pounds of dry matter and 23.6 pounds of digestible nutrients. This was enough in excess of maintenance requirements for the production of 39 pounds of milk. The cows actually produced 41.5 pounds. The quantity of grass consumed per cow per day was only 2.9 per cent of that standing on one acre.

In 1933 chemical analyses were made only for moisture. For this reason, the total digestible nutrients for the last three trials were estimated

from the twelve preceding trials in which the total digestible nutrients were found to be 69.09 per cent of the dry matter.

INFLUENCE OF AIR TEMPERATURE

The data presented in table 3 afford but little opportunity to make a direct comparison of the influence of different air temperatures on the quantity of grass the cows grazed, because in most cases the cooler temperatures were accompanied by more abundant pasturage. Probably the only data suitable for such a comparison are those from the trials with Holstein cows in April and July, 1933. Although there was somewhat more herbage on the ground in July than in April, it appears there was enough in April so the cows could graze their fill. The grass in July and April was similar in dry matter content and stage of maturity. The cows ate an average of 154 pounds of grass a day in April and 146 pounds in July. In April the maximum temperature was 71° F., and the minimum was 29°. In July the maximum was 88° and the minimum 60°. It appears from this one comparison that a warm temperature did not materially lessen the consumption of grass. However, it should be noted that the maximum temperature of 88° and the minimum of 60° for July lack somewhat of being as high as those frequently occurring during the summer season at Beltsville.

INFLUENCE OF BREED ON THE QUANTITY OF GRASS GRAZED

Both the Jerseys and Holsteins were heavier than the average for the breed. The average weight of the cows in the 7 comparative trials was 1,053 pounds for the Jerseys and 1,392 pounds for the Holsteins. The average quantity of green grass eaten a day was 106 pounds for the Jerseys and 110 pounds for the Holsteins. The average daily consumption of dry matter was 22.8 and 25.4 pounds, respectively. Possibly this difference in consumption can be best explained by the difference in the size of the two breeds as one would naturally expect large cows to eat more than small ones. The Jerseys, however, ate somewhat more than the Holsteins per unit of body weight.

QUANTITY OF MILK AND BUTTERFAT FOR WHICH THE GRAZED GRASS WOULD PROVIDE THE NUTRIENTS

If no allowance is made for the energy used in the act of grazing, the digestible nutrients consumed in May, 1932, in excess of the quantities required for maintenance, were enough on the basis of the Savage standard for the production of 26 pounds of milk and 1.23 pounds of butterfat a day by the Jerseys and 35 pounds of milk and 1.04 pounds of butterfat by the Holsteins. In June the Jerseys ate enough for 15 pounds of milk and .66 pound butterfat; the Holsteins enough for 13 pounds of milk and .45 pound

butterfat, if the one trial that was out of line is disregarded. In August the Jerseys ate enough for 5 or 6 pounds of milk and .26 pound of butterfat; the Holsteins enough for 2 or 3 pounds of milk and .06 pound butterfat. In April, 1933, the Jerseys ate enough for 40 pounds of milk and 1.80 pounds butterfat; the Holsteins enough for 45 pounds of milk and 1.72 pounds butterfat. Holsteins in the final trial in July, 1933, ate enough for 39 pounds of milk and 1.42 pounds of butterfat.

Calculations based on the Savage standard show that the quantity of digestible protein consumed by the cows was in every instance much in excess of that required for the production of the quantities of milk mentioned above. The phosphorus intake was also well above the quantities specified as necessary by Huffman (2) of the Michigan Agricultural Experiment Station. The calcium intake on the average was almost twice that of the phosphorus intake. Milk contains only about one-third more calcium than phosphorus. If it is assumed that the calcium and phosphorus ingested are equally well retained (and there is some justification for such an assumption (3)), then there was no deficiency of calcium. It appears that if a cow will eat enough immature grass to provide the required digestible nutrients and if this grass has a normal content of minerals, her ration is not likely to be deficient in any of the essential food constituents.

These trials show that cows will eat enough grass when the pasturage is at its best to produce well over a pound of butterfat a day. They also show that the pasturage may often become so sparse or short in midsummer as to provide no more than the maintenance requirement. The reason that cows lose flesh and decline rapidly in milk flow in the summer is apparently due almost entirely to a lack of sufficient feed.

PRACTICAL APPLICATIONS

These trials indicate that a cow will graze in a day about 6 per cent of the immature grass standing on 1 acre of ground, and that the limit of her capacity is about 150 pounds of grass a day; or perhaps it may be better stated as 30 to 35 pounds of dry matter, depending on her size. This means that the pasture would have to yield 2,500 or more pounds of grass to the acre, with a dry matter content of 20 per cent, to permit the cow to graze her fill.

There seems to be no practical way of determining and describing how good a pasture is. As a rule, it would be impossible to determine from the appearance of a pasture that cows would eat a certain amount of grass a day, or that the pasture would support a milk flow of a certain quantity, or that any definite quantity of supplementary feed would have to be supplied. Therefore, it is suggested that the cow herself be allowed to make up for any shortage of grass by permitting her to have all the hay or silage

or both that she will clean up at least once a day, throughout the grazing season. When the pasturage is good she will eat but little roughage, but when it is poor she will eat much more. If feeding is managed in this way, probably the intake of nutrients in pasturage and roughage combined will vary but little; and the grain allowance, if any, can be kept fairly uniform throughout the entire season. In any system of feeding one must be certain that the allowance of protein is ample. This proposed method of feeding and management needs to be confirmed by experimental work before it can be definitely advocated.

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VITAMIN D STUDIES IN CATTLE

IV. CORN SILAGE AS A SOURCE OF VITAMIN D FOR DAIRY CATTLE*

H. ERNEST BECHTEL,** C. F. HUFFMAN, C. W. DUCAN
AND C. A. HOPPERT

*Sections of Dairry Husbandry and of Chemistry, Michigan Agricultural Experiment
Station, East Lansing*

In previous reports from this Station, experimental data have been submitted upon the antirachitic value of sun-cured hay for dairy cattle (1), the vitamin D sparing action of certain magnesium compounds when only small amounts of this vitamin were present in the dairy ration (2), and the essential nature of radiant energy in the dietary régime of the dairy calf (3). The present report is concerned with the antirachitic value of corn silage for dairy cattle.

Hess and Weinstock (4) reported that green plants grown in the dark contained no vitamin D but became antirachitic after ultraviolet irradiation. Bethke, Kennard and Kik (5) failed to prevent leg weakness in chicks when green, fresh red-clover was fed as 50 per cent of the ration. Steenbock and associates (6) found that clover hay cured in the dark was inactive antirachitically. Mellanby and Killick (7) reported that summer-grown grass contained more of the calcifying factor than cabbage. Green spinach grown in midsummer has been reported by Chick and Roscoe (8) to have a slight but appreciable antirachitic value. While an investigation regarding the actual feeding of fresh, green plants as a source of vitamin D to dairy cattle is lacking, the indications are that fresh, green pasture grasses, in general, are poor sources of antirachitic substances.

As previously indicated (1), the antirachitic potency of hays is related to their exposure to solar ultraviolet rays. It is the usual practice to harvest corn for silage when many of the ears have become dented, the bottom three or four leaves and a portion of the husk have become dry while the remainder of the plant is still green. Corn at this stage of maturity is mostly green plant substance and for this reason has been considered a poor source of vitamin D, although this point has not been specifically investigated. Because of the presence of sun-dried leaves, however, and other material

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on the plant at the time of ensiling, it was thought possible that corn silage might have an appreciable antirachitic value.

The object of this investigation was to determine the antirachitic value of corn silage for dairy cows.

EXPERIMENTAL

The corn silage was made from dent corn which was cut when the kernels were dented and the lower leaves were dry. One sample of silage was taken for each of the following years, 1931-1934, inclusive, for biological assay with rats. Each sample of silage was immediately put in a drying room at 50°-60° C. after collection and after about one week, the dried material was ground and stored in stoppered bottles at room temperatures until needed for assaying. The vitamin D content of the silage was determined by the curative feeding technique with rats according to a standard line-test procedure. The vitamin D contents of the silage, in terms of U. S. P. rat units, are shown in Table 1.

TABLE 1
Vitamin D content of silage, U. S. P. rat units

CURATIVE MATERIAL	UNITS PER POUND DRY MATTER*
Corn silage 1931	165
Corn silage 1932	122 -
Corn silage 1933	122
Corn silage 1934	165

* Air dried basis.

The nineteen grade-Holstein dairy calves of either sex which were used in this experiment were divided into 5 groups. The calves in the first 4 groups were placed on experiment at birth but the calves in group 5 were several months of age when placed on this experiment. The management of the calves and the composition of the rachitogenic calf ration were similar to that previously reported (1-3). Blood samples were obtained from each of the experimental calves every two weeks and the plasma from each sample was analyzed for calcium, inorganic phosphorus (9) and magnesium (10) by methods already recorded. At the time of post-mortem examination, certain bones were saved from each animal and studied histologically (11). The chemical analysis of the various feeds used in this investigation are given in Table 2.

The calves in Group I, C-140, C-161 and C-164, were fed the unsupplemented basal rachitogenic ration. The calves in Group II, C-135, C-139 and C-141, each received the ash from one pound of dry silage per day in addition to the basal ration. The calves in Group III, C-132, C-136, C-137,

TABLE 2
Chemical analysis of feeds and water

MATERIAL	MOISTURE	Ca	P	Mg
	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>
Whole milk		0.120	0.093	0.012
Skim milk		0.122	0.096	0.012
Corn and oats	11.80	0.128	0.321	0.156
Grain mixture	11.30	0.494	0.364	0.199
Corn silage 1931-32*	76.61	0.175	0.062	0.122
Corn silage 1932-33	78.02	0.101	0.054	0.067
Corn silage 1933-34	70.51	0.103	0.054	0.088
Corn silage 1934-35	69.00	0.126	0.064	0.115
Corn silage ash		7.190	2.950	6.770
Water		0.0082		0.0027

* Each year's analysis began with September.

C-138 and C-145, received from one to six pounds of silage per day per animal. Following the above curative feeding trials, the calves in Group IV, C-156, C-159 and C-160, were used in a preventive trial. The calves in this group received the basal ration but corn silage was added as the sole source of vitamin D when the calves were 30 days of age. The calves in the above groups which survived were slaughtered at approximately 190 days of age, with the exception of C-159 which was changed to another experiment.

Calves C-168, C-169, C-188, C-195 and C-167 were subsequently added to this experiment as Group V. The first four calves were rachitic at the time when silage was added to their basal rachitogenic ration. Calf C-168 was 269 days of age and had been suffering from rickets for about 50 days, calf C-169 was 348 days of age and had been suffering from rickets for about 100 days, calf C-188 was 428 days of age and had had rickets for more than 200 days and calf C-195 was 395 days of age and had had rickets for at least 60 days when silage was added to their rations. Calves C-168 and C-169 were subsequently slaughtered, C-188 died while on experiment and C-195 was continued on experiment to determine the effect of the ration upon growth and reproduction. Calf C-167 was normal when silage was added to the ration.

RESULTS

The results obtained from the experiment are presented in Tables 3-7, inclusive. Table 3 summarizes the data pertaining to the age when the calves were placed on experiment, the age when the supplement was added, the first evidence of rickets, the age of the calves at the termination of the experiment and the terminal plasma calcium, magnesium and inorganic phosphorus values. Table 4 gives the data for a representative animal in Groups I-IV, inclusive.

TABLE 3
Summary of data pertaining to calves which received the rachitogenic ration

CALF	EXPER. STARTED. AGE	SUPPLEMENT ADDED. AGE	RACHITIC. AGE	EXPER. ENDED. AGE	TERMINAL PLASMA		
					Ca	P	Mg
no.	days	days	days	days	mg. per 100 cc.		
Group I. Basal ration							
C-140	1	none	73	88 D ¹	9.4	13.80	2.33
C-161	1	"	127	162 D	9.3	9.06	2.19
C-164	1	"	108	158 D	8.8	6.69	1.87
Group II. Basal ration plus silage ash							
C-135	1	93	72	108 D	6.8	6.51	2.80
C-139	1	90	71	114 D	7.3	8.62	1.68
C-141	1	79	73	193 S ²	8.4	5.84	2.43
Group III. Basal ration plus silage							
C-132	1	93	93	193 S	8.2	3.81	2.00
C-136	1	95	81	191 S	8.6	3.68	2.45
C-137	1	92	67	192 S	8.6	3.50	
C-138	1	86	86	193 S	10.0	7.35	2.82
C-145	1	92	92	190 S	10.0	2.27	2.45
Group IV. Basal ration plus silage before the onset of rickets							
C-156	1	32	161	186 S	7.5	3.63	1.56
C-159	1	33	116	190 ³	—	—	—
C-160	1	30	95	193 S	8.0	3.01	1.80
Group V. Basal ration plus silage (older calves)							
C-167	192	192	none	1140 ⁴			
C-168	269	269	210	371 S	11.9	7.27	3.12
C-169	348	348	248	414 S	12.3	6.79	2.45
C-188	428	428	225	520 S	8.5	4.13	2.33
C-195	366	366	300	813 ⁵			

¹ D denotes died. ² S denotes slaughtered. ³ Changed to another experiment. on experiment. ⁴ Changed to another experiment, cow still alive.

Group I.—The three calves in this group received the unsupplemented basal ration. Anorexia was manifested by C-140 and C-161 after the onset of rickets and C-161 also had a convulsion at 162 days of age. C-164 had a severe convulsion at 128 days of age at which time 5 cc. of parathormone was injected subcutaneously. A mild convulsion was again noted at 157 days of age and the calf was found dead on the following day. The condition of the pen indicated that the calf had died in a convulsion.

Group II.—The three calves in this group had their basal rachitogenic ration supplemented with silage ash. C-135 contracted bilateral pneumonia

TABLE 4
Growth data, mineral and silage intakes and blood plasma values of representative calves

AGE		WT.	HT.	DAILY SILAGE INTAKE				AV DAILY INTAKE				BLOOD PLASMA			
				Slilage	D.M.	lb.	gm.	D.M. per kilo	Vit. D units	Ca	P	Mg	Ca	P	Mg
days	lb.	cm.		lb.			gm.			mg per 100 cc.					
Group I. C-161. Basal ration															
									I. S. P	gm.	gm.	gm.			
										4.3	3.3	0.4	13.1	6.53	2.21
30	88	79								8.8	6.1	1.4	12.6	6.25	2.62
60	122	82								9.8	9.3	2.0	10.6	7.95	2.36
90	144	86								12.7	9.8	2.4	10.7	7.42	2.16
120	163	89								8.9	6.7	3.4	8.5	5.37	1.80
150	169	90											8.8	7.28	2.13
162 ¹															
Group II. C-141. Basal ration plus silage ash															
										8.3	7.6	1.5	9.2	5.63	2.80
70 ²	132	78								14.8	9.4	3.2	8.4	6.89	1.95
100	162	83								14.2	10.1	4.8	7.1	6.38	1.85
130 ³	192	87								11.1	7.3	5.3	6.9	5.80	1.71
160 ³	199	90								11.0	7.3	5.3	7.8	5.11	2.03
190 ³	202	91											8.4	5.84	2.43
193 ⁴	201														
Group III. C-145. Basal ration plus silage															
										14.2	10.2	3.7	9.5	4.66	2.58
100	188	85		2.1	0.5	2.6	60	19.3	12.8	7.1	10.3	3.10	2.29		
130	239	89		5.6	1.3	5.7	159	17.1	9.9	7.8	11.4	3.11	2.60		
160	277	92		6.0	1.4	5.4	171	16.6	9.2	7.4	10.7	2.99	2.44		
190 ⁴	280	96		5.8	1.4	4.8	166								
Group IV. C-159. Basal ration plus silage before the onset of rickets															
										4.6	3.5	0.5	12.1	6.55	2.41
30 ⁵	102	77								8.5	7.0	1.1	11.9	6.60	2.36
60	123	80								10.0	9.1	2.2	11.7	5.82	2.21
90	152	84					19	13.7	10.3	3.0	9.9	7.25	2.37		
120	184	88	0.7		0.2	1.3	27	9.3	6.1	3.9	8.5	5.46	1.98		
150 ⁶	202	90	1.0		0.2	1.4	46	11.3	7.7	4.8	8.0	6.82	1.99		
180	238	92	2.5		0.6	2.4	67								
210 ⁷	229		3.1		0.7	3.0	83								

¹ Convulsion, died. ² Added silage at 78 days of age. ³ Convulsions 129, 167, 183, and 184 days of age. ⁴ Slaughtered. ⁵ Added silage at 32 days of age. ⁶ Stiff at 166 days of age. ⁷ Convulsions at 198 days of age, injected 5 cc. of parathormone subcutaneously. Removed from experiment at 210 days of age.

and died at 108 days of age. C-139 had a convulsion at 88 days of age and died at 114 days of age. C-141 had convulsions at 129 and 167 days of age. Parathormone was injected after each convulsion. Convulsions were again noted at 183 and 184 days of age. The calf was slaughtered at 193 days of age.

Group III.—After 90 days of age, the five calves in this group received the basal ration supplemented with small amounts of silage. All of the calves showed the clinical evidences of rickets from 62 to 93 days of age. C-137 had convulsions at 83 and at 90 days of age. The corn silage supplement was started at 92 days of age and convulsions were observed at 128 days of age. The calves in this group were slaughtered at approximately 190 days of age. C-145 was representative of this group, therefore, the calcium, phosphorus and magnesium intakes and the concentration of these constituents in the blood plasma are presented in Table 4.

Group IV.—The three calves in this group had their ration supplemented with corn silage at about 30 days of age and before the onset of rickets. The calves did not develop rickets until they were from 95 to 161 days of age. They did not consume enough silage at an earlier age to prevent rickets but the silage consumption tended to delay the symptoms. As they became older an insufficient amount of silage was consumed to prevent rickets because of anorexia. C-156 and C-160 were slaughtered at about 190 days of age and C-159 was changed to another experiment at 210 days of age. The representative experimental data secured from C-159 are presented in Table 4.

Group V.—With the exception of C-167, the older calves which were used in this group to determine the antirachitic effect produced by the ingestion of large amounts of silage were rachitic when placed on experiment.

Calf C-167. This calf had previously been used to determine the efficacy of solar ultraviolet radiation in preventing the manifestations of rickets (3). Table 5 presents the growth data, feed consumption and blood plasma values from 210 days of age until the termination of the experiment. She received corn silage as the sole source of vitamin D at 192 days of age and ate it with avidity from the very beginning, grew normally and maintained a sleek appearance at all times. C-167 was first bred at 467 days of age and again at 487 and 515 days of age. She aborted at 601 days of age and was again bred at 662 and 765 days of age. Beginning at 920 days of age, all grain was withheld from the ration and corn silage was the sole source of food other than wood shavings, salt and water. This heifer gave birth to a normal 85-pound heifer calf at 1032 days of age and had a retained placenta. C-167 averaged approximately 45 pounds of milk per day, containing 3.5 per cent fat, during the first 100 days of lactation on a ration which consisted of the rachitogenic grain mixture, corn silage, wood shavings, salt and water. Pre-

TABLE 5
C-167. Growth data, mineral and stage intakes and blood plasma values¹

AGE	WT.	HT.	DAILY SILAGE INTAKE			A. DAILY INTAKE				BLOOD PLASMA			
			Silage	D.M.	D.M. per kilo	Vit D units	Ca	P	Mg	Ca	P	Mg	mg per 100 cc.
days	lb.	cm.	lb.	lb.	gm.	U S P	gm.	gm.	gm.				
210	314	98	3.0	1.1	3.3	129	14.9	9.9	6.5	10.4	8.23	9.47	
240	345	102	11.7	2.6	7.4	315	16.1	10.1	7.8	11.7	7.60	2.68	
270	401	103	16.5	3.6	9.0	445	19.3	12.0	9.7	12.2	7.81	3.12	
300	453	108	18.7	4.1	9.0	402	22.0	13.8	11.0	11.4	7.36	2.48	
330	486	109	16.3	3.6	7.4	440	20.2	12.6	10.0	11.7	7.75	3.47	
360	546	111	19.3	4.3	7.8	521	23.3	14.5	11.6	11.4	6.85	3.47	
390	607	114	20.0	4.4	7.2	539	23.7	14.8	11.9	12.3	7.60	3.09	
420	645	117	20.0	4.4	6.8	539	23.8	14.8	11.9	11.9	7.24	3.33	
450 ²	708	119	20.0	4.4	6.2	539	25.4	15.9	12.5	10.9	7.25	3.11	
480	739	120	20.0	4.4	5.9	539	30.4	19.3	14.5	11.3	6.99	2.67	
510	813	122	20.0	5.9	7.2	723	34.5	21.4	17.9	11.3	6.92	3.03	
540	847	123	20.0	5.9	7.0	723	34.1	21.4	17.7	11.6	6.16	3.03	
570	852	123	20.0	5.9	6.9	723	33.0	21.4	17.3	12.5	6.16	3.19	
600 ³	850	124	14.1	4.1	4.8	506	22.1	13.9	11.7	12.9	5.63	3.16	
630	858	126	16.5	4.9	5.7	506	21.7	13.0	12.1	13.0	6.05	2.88	
660 ⁴	857	127	14.8	4.4	4.9	534	22.7	14.1	12.2	11.9	5.85	2.61	
690	924	126	19.5	5.8	6.2	705	26.1	16.6	14.6	11.4	5.00	2.82	
720	973	129	20.0	5.9	6.1	723	28.5	18.1	15.5	10.6	5.73	2.78	
750 ⁴	1031	129	22.3	6.6	6.4	808	27.7	17.1	15.8	10.8	5.68	2.77	
780	1070	129	30.7	9.0	8.4	1107	25.8	14.1	16.7	11.0	5.86	2.53	
810	1103	130	30.0	8.9	8.0	1084	26.2	14.0	16.6	11.6	6.94	2.26	
840	1150	131	32.2	9.5	8.2	1161	24.2	13.1	16.4	11.1	6.65	2.45	
870	1186	132	35.0	10.9	9.1	1329	27.3	13.5	21.3	11.6	6.63	3.00	
900	1208	133	35.0	10.9	9.0	1329	28.2	13.5	21.3	10.8	6.87	2.76	
930	1233	133	38.7	12.0	9.7	1407	26.7	13.3	21.9	10.4	6.16	3.14	
960	1251	133	45.0	14.0	11.1	1709	26.9	13.1	23.8	10.9	6.56	3.49	
990	1254	132	40.6	12.6	10.0	1547	24.7	12.8	21.7	10.6	6.07	2.71	
1020 ⁵	1187	132	41.8	13.0	10.9	1587	24.8	12.1	21.8	10.5	5.72	2.63	
1050	1044	133	32.9	10.2	9.8	1250	33.8	19.2	23.1	9.8	4.45	3.06	
1080	1090	133	40.7	12.6	11.6	1346	67.0	41.5	38.6	10.9	4.99	2.57	
1110	1124	132	44.6	13.8	12.3	1695	76.1	47.4	43.6	11.0	5.13	2.76	
1140	1149		45.0	14.0	12.1	1708	76.3	47.7	43.6	10.5	3.91	3.22	

¹ Data from birth to 190 days of age appeared in Paper III, (3) this series.

² Bred at 467, 487 and 515 days of age.

³ Aborted at 601 days of age.

⁴ Bred at 662 and 765 days of age.

⁵ Calved at 1032 days of age.

liminary results indicate that the milk produced by C-167 contained considerably less than 2.7 U. S. P. vitamin D units per quart. The blood plasma data fail to reveal any significant variations from normal. However, there were two gradual drops in the inorganic phosphorus values. The first drop was associated with the natural physiological disturbance due to abortion and the second was due to parturition.

Calf C-168. This calf received from 15 to 20 pounds of corn silage per day as the sole source of vitamin D from 269 days of age until the end of the experiment. The calf was suffering from severe rickets when first placed on experiment and the blood calcium and inorganic phosphorus values were 7.6 and 9.84 mg. per 100 cc. of plasma, respectively. The silage was readily consumed from the beginning and at 303 days of age the calf was able to rise to its feet with much less difficulty than a week earlier. The plasma calcium and inorganic phosphorus values were 9.3 and 5.48 mg. at 303 days of age and by the following week they had returned to normal, 10.9 and 6.76 mg., respectively. The gains in body weight were also greater from this time on until the animal was cured of rickets and slaughtered at 371 days of age. The terminal calcium and inorganic phosphorus values were 11.9 and 7.27 mg. The kidneys showed extensive areas of scar tissue.

Calf C-169. This calf received 15 pounds of corn silage per day as the sole source of vitamin D beginning at 348 days of age. It was severely rachitic and had difficulty in rising to its feet. The blood calcium and inorganic phosphorus values were 8.0 and 5.84 mg. per 100 cc. of plasma. The corn silage was readily consumed and 10 days later the calf was able to rise to its feet with much less difficulty. The blood values were approaching their normal concentrations by 370 days of age and the calf began to gain in body weight. C-169 was cured from rickets when slaughtered at 414 days of age and the terminal calcium and inorganic phosphorus values were 12.3 and 6.79 mg. The kidneys showed more extensive areas of scar tissue than observed in C-168. The data are tabulated in Table 6.

Calf C-188. This calf was 428 days of age and had been suffering from rickets for more than 200 days when corn silage was added to the ration as the sole source of vitamin D. The animal was severely rachitic at this time and was only maintaining a constant body weight. The blood calcium and inorganic phosphorus values were 7.2 and 7.06 mg. per 100 cc. of plasma. The silage was readily eaten but the grain was refused part of the time. By 472 days of age the animal was extremely stiff and lame and was rarely seen standing so that it became necessary to place the feed in a basket on the floor of the stall. The plasma calcium had now increased to 7.8 mg. but the inorganic phosphorus had declined to 4.51 mg. Placing the feed before the animal resulted in an increase in silage consumption but no improvement was noticed in its well-being. At 504 days of age the animal was observed

TABLE 6
C-169. Growth data, mineral and silage intakes and blood plasma values

AGE	WT.	HT.	DAILY SILAGE INTAKE			V DAILY INTAKE			BLOOD PLASMA			
			Silage	D.M.	D.M. per kilo	Vit D units	Ca	P	Mg	Ca	P	Mg
days	lb.	cm.	lb.	lb.	gm.	I. S. P.	gm.	gm.	gm.	mg. per 100 cc.		
340 ¹	364	98					15.7	10.9	6.3	8.0	5.84	2.62
347 ²	360						16.6	11.6	5.6			
350	360		6.7	1.5	4.1	180	18.2	12.1	8.1	9.6	4.22	3.31
360	367		14.5	3.2	8.7	391	18.9	11.8	9.3	10.6	4.70	2.28
370	377		15.0	3.3	8.7	404	19.2	11.9	9.5	10.5	5.25	3.43
380	372	103	15.0	3.3	8.9	404	19.2	11.9	9.5	11.0	5.65	2.90
390	387		15.0	3.3	8.5	404	19.2	11.9	9.5			
400	402		15.0	3.3	8.2	404	19.2	11.9	9.5	11.6	6.25	3.02
410	421	105	15.0	3.3	7.8	404	19.4	11.9	9.5		6.07	
414 ³	447		15.0	3.3	7.4	404	19.4	11.9	9.6	12.3	6.79	2.45

¹ Convulsion at 344 days of age.

² Started on silage at 348 days of age.

³ Slaughtered.

struggling to its feet, breathing hard and with nostrils distended. The following week C-188 was emaciated, unable to rise to its feet and refused all feed and water. The plasma calcium and inorganic phosphorus values at this time had declined to 7.1 and 2.44 mg. The animal lapsed into a comatose condition at 518 days of age and failed to respond appreciably either to intravenous injections of solutions of calcium gluconate, glucose and magnesium sulfate or to a subcutaneous injection of viosterol. Death occurred at 520 days of age. There were patches of scar tissue in the kidneys, the muscle tissue showed considerable edema and there were evidences of muscle injury around the leg joints. The most characteristic autopsy finding was the generalized condition of pitting and erosion of the articular surfaces of the long bones. Illustrations and a detailed description of the histological findings are given elsewhere (11).

Calf C-195. This calf was 366 days of age and had suffered from rickets for more than 60 days when corn silage was added to the rachitogenic ration as the sole source of vitamin D. The animal's legs were stiff and the knees were bowed markedly. The plasma calcium and inorganic phosphorus values were 9.5 and 3.01 mg. per 100 cc. at this time. The appetite for silage was only fair but it gradually improved and by the following month the calf was able to rise to its feet with much less effort. The addition of silage had little effect upon the blood constituents during the first two months but during the next two months, the concentration of calcium returned to normal and the inorganic phosphorus manifested a slow but steady rise. Estrus was first noted at 413 days of age, at which time the bowing of the knees had become less marked. Improvement was rapid after that time. C-195 had recovered from rickets by 543 days of age, was bred and thereafter made normal gains in body weight. The heifer gave birth to a normal 82-pound bull calf at 813 days of age. The data secured from this animal are summarized in Table 7.

DISCUSSION

When calves less than 190 days of age were used as test animals it was impossible to either cure or prevent rickets by supplementing the basal rachitogenic ration with corn silage. A larger percentage of the calves survived until 190 days of age, however, when silage supplemented the basal ration (Table 3). This suggested that silage exerted some antirachitic activity although the amount ingested was insufficient to maintain or to restore health. Higher intakes of silage were precluded by anorexia. Calf C-145 had the best appetite for silage but the average consumption was less than six pounds per day. This amount of silage was equivalent to a daily intake of approximately 5 grams of silage dry-matter per kilo of body weight and was ineffective in curing rickets. The ingestion of three pounds of corn silage per day failed to prevent rickets in young calves.

TABLE 7
C-195. Growth data, mineral and silage intakes and blood plasma values

AGE	WT.	HT.	DAILY SILAGE INTAKE				AV DAILY INTAKE				BLOOD PLASMA			
			Silage	D.M.	D.M. per kilo	Vit. D units	Ca	P	Mg	Ca	P	Mg	mg. per 100 cc.	
days	lb.	cm.	lb.	lb.	gm.	U.S.P.	gm.	gm.	gm.	12.0	6.45	2.68		
240	471	110					19.2	13.2	7.6	10.0	7.30	3.15		
270	514	112					19.5	13.2	7.8	10.3	5.74	2.53		
300	527	115					18.8	13.2	7.5	9.7	4.98	2.52		
330	536	116					18.5	13.2	7.4	10.1	4.37	2.60		
360	545	117					18.5	13.2	7.4	9.5	3.01	2.50		
365 ¹	549													
390	547	118	16.1	4.3	7.9	532	25.2	16.6	13.5	9.7	2.49	2.43		
420 ²	532	120	18.5	5.5	10.2	669	24.8	16.1	13.9	9.8	2.99	2.28		
450	560	121	17.8	5.3	9.4	643	24.7	15.9	13.7	10.3	3.54	2.35		
480	577	122	15.7	4.6	8.0	567	25.1	16.0	13.3	11.1	5.61	2.15		
510	620	125	19.5	5.8	9.3	705	25.1	15.6	14.1	10.9	5.56	2.09		
540 ³	655	125	23.8	7.4	11.2	903	26.2	15.2	17.4	11.6	5.63	2.50		
570	670	123	19.5	6.1	9.0	741	23.8	14.9	16.2	11.6	5.98	2.35		
600	705	126	24.2	7.5	10.6	919	26.8	18.0	19.1	11.7	6.03	2.98		
630	724	127	24.8	7.7	10.6	941	26.7	15.5	17.9	11.4	5.78	2.89		
660	770	126	25.9	7.0	9.1	857	26.1	14.8	17.0	11.8	6.00	2.55		
690	823	126	27.2	8.4	10.2	1034	27.4	16.2	18.9	11.3	6.78	2.57		
720	842	127	28.9	9.0	10.6	1099	28.0	16.4	19.7	11.7	6.83	2.87		
750	873	127	27.2	8.4	9.6	1034	28.6	16.2	19.3	11.0	6.39	2.77		
780	911		26.9	8.3	9.1	1020	27.3	16.6	18.8	11.5	5.93	2.59		
810	921		25.5	7.9	8.6	971	26.8	15.7	18.2	10.6	5.56	2.62		
813 ⁴										10.0	4.19	2.58		

¹ Started on silage at 365 days of age.

² Estrus noted at 413, 457, 520 and 543 days of age.

³ Bred at 543 days of age.

⁴ Calved at 813 days of age.

When older calves were used, the clinical manifestations of rickets were alleviated in three out of four cases by the daily ingestion of 15 to 20 pounds of silage (Tables 6-7). Rickets was also prevented in C-167 from six months to three years of age by the ingestion of corn silage (Table 5). The abortion of C-167 was probably not associated with a vitamin D deficiency in view of the results reported by Moore and associates (12). The decrease in the concentration of inorganic phosphorus in the plasma of C-167 and C-195 at the time of parturition and the abortion of C-167 was associated with the physiologic disturbances caused by these acts rather than by a deficiency of the antirachitic factor. It has been shown (9) that such a change in the composition of the blood plasma is not uncommon in dairy cattle at the time of parturition.

In order to compare the results obtained with the various animals it seems convenient to express the intake of corn silage in terms of grams of silage dry-matter per kilo of body weight. On this basis, 7 to 10 gm. of silage dry-matter per day was not only effective in curing and preventing rickets but also supplied a sufficient amount of the antirachitic factor for normal growth and reproduction.

Calf C-188 ingested from 15 to 20 pounds of silage per day which was equivalent to 8 to 12 gm. of silage dry-matter per kilo of body weight, yet failed to recover from rickets. This was the only one of the older calves which failed to respond favorably to silage feeding. This calf is regarded as an atypical case. The inability to cure C-188 is ascribed to the severity of the rachitic condition which had developed before curative measures were begun. Failure to utilize its feed properly, together with its emaciated appearance and autopsy findings in the joints, indicate that the animal was suffering from far-advanced rickets which had given rise to other nutritional disturbances refractory to ordinary vitamin D therapy. Hutyra and Marek (13) state that if rickets is far advanced and has given rise to emphatic nutritional disturbances, death always follows, either through exhaustion or through some complication. The ultimate healing of the process is frequently prevented by ulcers formed in the course of the disease in the articular cartilages.

Bioassays made with rats indicated that 7.5 to 10.0 gm. of dry corn silage contained an equivalent of 2.7 U. S. P. units of vitamin D (Table 1). Assuming that 10.0 gm. of dry silage contained 2.7 U. S. P. rat units, during the period 1931-1934 inclusive, the daily intake of vitamin D units was calculated for each of the experimental calves (Tables 4-7).

The representative tables included in this paper show that the addition of corn silage to the rachitogenic ration appreciably increased the intake of magnesium. In view of the results of a recent investigation (2), it is possible that the presence of magnesium in silage may augment the efficacy of the antirachitic material in corn silage.

SUMMARY AND CONCLUSIONS

1. It was the purpose of this investigation to determine the antirachitic value of corn silage for dairy calves by the use of both curative and preventive feeding trials.

2. Samples of corn silage for the years 1931-1934 contained from 122 to 165 U. S. P. vitamin D units per pound of dry matter.

3. Calves less than 190 days of age were unsuitable test animals for both curative and preventive trials because of anorexia and failure to ingest adequate amounts of silage. In one instance, the feeding of corn silage to a yearling calf failed to cure severe rickets complicated with muscle atrophy and erosion of the articular surfaces.

4. The daily ingestion of an equivalent of 7.0 to 10.0 gm. of dry corn silage per kilo of body weight was effective in curing and preventing rickets in yearling calves and also supplied sufficient antirachitic material for normal growth and reproduction in dairy cows.

5. When corn is cut at the usual stage of maturity for corn silage it possesses definite antirachitic qualities when fed to dairy cows.

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THE INFLUENCE OF STORAGE, PASTEURIZATION, AND CONTAMINATION WITH METALS ON THE STABILITY OF VITAMIN C IN MILK

C. H. WHITNAH, W. H. RIDDELL, AND W. J. CAULFIELD
Kansas Agricultural Experiment Station, Manhattan¹

In 1921 Hess (1) stated that “. . . it requires a minimum of about 16 ounces of cow's milk to protect an infant from scurvy or to cure it.” Today, however, milk is almost entirely ignored as a source of vitamin C. This is probably due to the fact that a majority of the early studies indicated that milk was an uncertain source of the antiscorbutic factor. On the other hand, the fact should not be overlooked that before the discovery of vitamin C, milk was the only important source of this vitamin for infants. More recently Schwartze, Murphy and Hahn (2) state “. . . we would estimate that 200 cc. daily of our raw milk less than 12 hours old would probably suffice to protect an infant from scurvy.”

Recently, while studying the influence of the cow's ration on the vitamin C content of milk, the authors were impressed with the appreciable amounts of this vitamin found in the samples tested (3). In 197 samples of fresh milk from individual cows the vitamin C content ranged from 17 to 37 milligrams per liter, averaging about 26.

While the vitamin C requirement of either adults or infants is not definitely known, 27 milligrams per day has been suggested as an adequate amount for an adult (4). Fresh milk, therefore, may be an important source of vitamin C. This vitamin C must be preserved until the milk is consumed if market milk is to be recognized as a reliable source.

Soon after the discovery of vitamin C, it was found that quick boiling of milk destroyed less of the vitamin than pasteurization at 143° F. for 30 minutes (5), and that contamination of the milk with copper greatly increased the loss (6). These findings were confirmed in later studies and some important differences were demonstrated with certain types of commercial pasteurizers (7, 8, 9, 10). It has not been determined whether the lower vitamin C content usually found in pasteurized milk is due to loss during the process of pasteurization, or to an increased rate of progressive loss after this treatment, or whether both may be contributing factors.

It is known that, during pasteurization, milk may be somewhat contaminated with the metals of which the pasteurizer is made (11, 12). The effect

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of contact with milk pail and storage can, and the effects of contact with metal and air in the process of cooling and straining are less certain. The relation of such slight contamination to either immediate loss of vitamin C or to increased progressive loss is unknown.

The present study was undertaken to determine more clearly the relative effect of several factors on the vitamin C in milk. The loss during storage of both raw and pasteurized milk was first studied. Loss during the process of pasteurization, and after contamination with metals either by direct addition to the milk, or by addition to the ration, was also studied.

I. INFLUENCE OF STORAGE AND PASTEURIZATION

Procedure

To obtain milk as free as possible from any kind of contamination, samples were taken directly from aluminum milk pails at the college dairy barn and cooled in glass bottles. Parts of some of these samples were pasteurized in 50 ml. pyrex glass flasks. Samples of milk were also obtained at several milk plants using different types of commercial pasteurizers.² Since some of these plants were as far as 125 miles from the laboratory, approximately 9 hours elapsed between the collection and testing of samples from such plants.

Samples were taken just before pasteurization and again after the milk had been pasteurized, cooled and bottled. They were packed in ice, brought to the college laboratory, and tested after several intervals for vitamin C with 2-6-dichlorophenolindophenol (Bessey and King 13). The samples were stored at approximately 40° F. during the intervals between tests. The types of pasteurizers studied, the intervals after pasteurization at which the milk was tested, the Vitamin C content and the losses due to storage, to pasteurization, and to both pasteurization and storage are shown in table 1.

Results

In the study of table 1, first consideration should probably be given to the greater stability of vitamin C in fresh raw milk than in any of either the raw or pasteurized samples secured at commercial pasteurizers. Even the usual procedure of straining and cooling over a well-tinned, copper, tubular cooler produced an appreciable loss during storage.

No immediate loss resulted from pasteurization by the short time high temperature method (Types B and D). This agrees with the results of other workers where pasteurization involved similar temperatures and holding periods (8, 9, 10). The progressive loss due to storage also was

² The help of Mr. O. L. Pretz of Kansas City, Mr. L. Bauman of Lawrence, and Mr. J. B. Jarvis of Topeka in securing and collecting these samples is very much appreciated.

TABLE 1

Influence of storage and pasteurization on vitamin C in milk

AVERAGE VALUES FOR VITAMIN C																		
TYPE		SAMPLES			Loss in per cent due to storage only, and to stor- age plus pasteurization. (Hours stored)													
		Number plants repre- sented	No sam- ples	Raw or Past.	Hours after sampling				2-24						9-24		9-48	
					2	9	24	48	Stor- age only				Stor- age only		Stor- age only			
					Vit. C in Mg./liters				Stor- age only				Stor- age only		Stor- age only			
FRESH RAW MILK (not pasteurized)																		
A	Direct from milk pail	1	1275	Raw	25.7													
	" " "	1	89	Raw	25.0		23.3											
	Strained, and cooled over well tinned copper	1	68	Raw	21.6		15.4										7	
LABORATORY FLASK PASTEURIZATION (Using raw milk aged 9 hours in type B and aged 3 hours in type C)																		
B	Pasteurizer used				Hold- ing time min.													
	Material				Temp. °F.													
	Conical flasks heated in water bath	1	13	Raw Past. % loss	21.0 21.3 -1.4		19.9 20.7 -4.0		5.2 2.8	1.4								
C	As in type B	1	8	Raw Past. % loss	20.5 15.8 23		17.5 13.3 24		39 35	50	29 23	42						

TABLE 1—(CONTINUED)

TYPE				SAMPLES			AVERAGE VALUES FOR VITAMIN C											
				Number plants re- presented	No. sam- ples	Raw vit. Past	Hours after sampling						Loss in per cent due to storage only, and to stor- age plus pasteurization. (Hours stored)					
							Vlt. C In Mg./litera						2-24					
							2	9	24	48			Stor- age only	Past + Stor- age only	Stor- age only	Past + Stor- age only	Stor- age only	Past + Stor- age only
Pasteurizer used	Mat- erial	Temp. ° F.	Hold- ing time min.															
COMMERCIAL PASTEURIZATION (Using mixed raw milk from night and morning, aged 17 hours and 5 hours respectively, when sampled)																		
D	Internal tu- bular con- tinuous flow (short time- high tem.)	160	0.3	2	3	Raw Past. % loss	17.1 16.9 1.7	15.0 16.1 -7.3	12.5 12.0 4.0				12	4.8	6		27 29	30
E	Tubular pre- heater, glass lined hold- ing vat	143	30	1	2	Raw Past. % loss	15.4 11.1 28	12.0 9.8 18	9.1 5.9 35				22 12		37		41 47	62
F	Spray vat	143	30	4	11	Raw Past. % loss	16.4 10.8 34	14.4 7.6 47	12.1 4.8 60				12 30		54		26 55	71
G	Coil vat	143	30	5	11	Raw Past. % loss	23.4 16.4 29	18.8 7.6 54	11.9 4.9 59				29 53	68			37 58	74
H	Internal tu- bular con- tinuous flow (30 min.-hold- ing	143	30	2	5	Raw Past. % loss	13.4 6.0 55	11.1 3.3 70	8.7 2.7 69						75		35 55	80

* Precision of measurement is about 1 mg. per liter. Variations of less than about 5 per cent have doubtful significance.

very much less than with any other method of pasteurization studied. In fact, practically no loss resulted from storage for 24 hours after pasteurization. This was true for both the laboratory pasteurization in glass flasks (Type B) and for commercial flash pasteurization in stainless steel equipment (Type D).

It was to be expected that pasteurization by holding at 143° F. for 30 minutes would reduce the vitamin C either immediately or after storage of the pasteurized milk. An immediate loss was found even when the milk was pasteurized in glass flasks where there was very little agitation and very little contact with outside air (Type C). The raw milk used in Type C pasteurizers did not show as good storage stability of vitamin C as the milk used in Type B pasteurizers. It was more nearly comparable to the raw milk used in the commercial pasteurizers. The first observed loss after pasteurization in commercial types E and G was only slightly greater than the immediate loss under laboratory conditions.

The loss of vitamin C on storage of pasteurized milk is shown in table 1 both as percentage of the first value after pasteurization, and also as percentage of the raw milk of equal age. By either comparison the progressive loss after type C pasteurization was no more than for the raw milk. Among all the commercial types using the 30 minute holding period, only the glass lined vat (Type E) produced pasteurized milk where loss of vitamin C on storage was as small as in the raw milk.

It was anticipated that the stainless steel spray vats (Type F) would be superior to the tinned copper coil vats (Type G) in conserving the vitamin C content of milk. The agitation of the milk was less vigorous in the spray vat and the stainless steel construction should minimize contamination with copper. The results indicated some superiority for type F compared to type G. That the difference was not as marked as was expected can be attributed to at least two possible factors. In the first place there was probably contamination of the milk with copper in equipment through which the milk was handled before and after pasteurization. This may account for the greater storage loss with type F than with type E. In the second place, as previously indicated, prolonged holding (143° F., for 30 min.) even without contact with any metal (Type C) resulted in serious loss of vitamin C.

In the commercial method using coil vats (Type G) it was possible to observe the rate of loss of vitamin C for the 2 to 24 hour storage period. The initial loss for these samples was not greatly different from the similar loss in samples similarly pasteurized in glass flasks (Type C). The progressive loss on storage was distinctly greater in type G than in types C or E, and slightly greater than in type F.

The internal tubular pasteurizers (Type H) should be as effective as the laboratory flasks (Type C) in avoiding contact of the hot milk with outside air. All the vat pasteurizers (Types E, F, G) permit much greater contact of the milk with outside air. On the other hand, the amount of metallic surface in contact with the milk and the velocity of the milk at this surface is greater in type H.

It was impossible to evaluate exactly the amount of exposed copper in various parts of the equipment in the two plants using type H pasteurizers, or to distribute the cause for the loss of vitamin C between the type of pasteurizer and the condition of the pasteurizer and accessory equipment. In one plant the vitamin C in the raw milk was improved by avoiding a poorly tinned cooler at the receiving vat. In the other plant the final cooler appeared to be the part containing most serious exposure of copper. When this cooler was used with a new short time high temperature pasteurizer, no serious loss of vitamin C was caused. In both plants the pasteurizers themselves appeared to be in fair condition. In these two plants both the initial loss and the progressive loss on storage were greater than for any other type of pasteurizer studied.

The results with laboratory type C and with commercial types E, F, G and H, indicate that the 30 minute holding process of pasteurization is not well adapted to the conservation of vitamin C in milk.

II. INFLUENCE OF CONTAMINATION WITH METALS

Procedure

The results just reported might suggest that contamination of milk with copper is indicated when the loss of vitamin C on storage after pasteurization is excessive. If addition of the metals contained in stainless steel should not increase the loss of vitamin C in milk, the unexpected loss in stainless steel vats could be assumed to be due to other causes.

The effect of added metals was studied by adding sulfates of several metals to the milk. Sulfates were used because they are readily soluble salts. The metals studied were copper, iron, nickel, and chromium. Although aluminum is corroded by milk, it was not included because it has repeatedly been found equal to glass in avoiding loss of vitamin C. Tin was not included because it is not readily corroded by milk and also because any solution in which it could be added must be very strongly acid.

The first tests were conducted with copper and iron solutions because these metals are known to catalyze the oxidation of vitamin C. The first object was to obtain an estimate of the minimum concentration of added metal needed to produce a detectable effect on the vitamin C in the milk. Preliminary tests with copper and iron were followed by a series of 8 tests using about the minimum detectable addition of metal. In each test the

sample of milk was divided into four parts. One was used as a standard or check and one of the metals was added to each of the other three parts. Copper in the concentration of 5 p.p.b. was used in each of these 8 tests. Ten p.p.b. of copper and 100 p.p.b. of iron were also used in 4 of the tests while in the other 4 tests these were replaced by 1000 p.p.b. of chromium and 1000 p.p.b. of nickel.

The amounts and kinds of metal added, the times at which vitamin C was tested, and the amounts found, are shown in tables 2, 3, and 4.

TABLE 2
Vitamin C in milk to which copper was added as sulfate^a

ADDED COPPERb P.P.M.	RAW VS PAST.	PER CENT OF INITIAL CONTENT	PER CENT OF LOSS 2 24 HRS. STORAGE	HOURS AT			
				2	9	24	48
				Vit. C in mg./liter			
0	R	100	23	23.4	21.5	17.9	11.1
	P	84	18	19.7	17.9	16.0	11.1
			% loss	16	17	11	0
0.1	R	92	45	21.5	18.5	11.7	6.2
	P	68	54	16.0	13.5	7.4	2.5
			% loss	25	27	37	75
0.3	R	80	79	18.5	13.5	3.1	3.7
	P	39	73	9.2	4.9	2.5	1.8
			% loss	50	64	19	51
0.6	R	68	84	16.0	7.4	2.5	2.5
	P	13	42	3.1	1.8	1.8	1.8
			% loss	80	76	28	28

* These samples were prepared from a single composite of morning's milk taken from a can at the college creamery about 7:30 a.m. The copper was added about 8:00 a.m. The pasteurization at 143° F. for 30 min. in glass flasks was completed about 9:00 a.m.

^b Addition to another sample of milk of 20 times the maximum amount of the water used in making these solutions caused no loss of vitamin C.

TABLE 3
Vitamin C in milk to which ferrous sulfate was added

ADDED IRON P.P.M.	PER CENT LOSS ON STORAGE				HOURS AFTER PASTEURIZATION					
					2		7		24	
	2-7 hrs.		7-24 hrs.		Vit. C in mg. per liter					
	raw	past.	raw	past.	raw	past.	raw	past.	raw	past.
0	16	13	46	54	19.2	17.6	16.1	15.3	8.7	7.0
1.0	18	17	36	45	15.2	14.0	13.1	11.7	8.4	6.4
			% loss		21	21	19	23	6	9

TABLE 4
Vitamin C in pasteurized milk to which various metals were added

METAL ADDED P.P.B.	AVERAGE		TEST NUMBER							
	Extra loss ^a	Mg /1	1	2	3	4	5	6	7	8
			Vit. C 24 hrs. after past. (mg./1)							
0	0	10.3	12.9	12.9	11.1	6.8	7.5	8.0	11.4	11.4
5 copper	28	7.4	7.4	8.0	8.0	3.7	6.1	6.1	10.1	10.1
10 "	60	4.2	3.1	3.7	6.8	3.1				
100 iron	8	10.1	12.3	12.3	9.9	6.1				
1000 nickel	19	7.9					4.7	6.1	10.1	10.8
1000 chromium	11	8.6					5.7	6.7	10.8	11.4

^a The losses were calculated as average percentages of the individual mg./1 of vitamin C in the samples to which no metal was added. Losses of less than 20 per cent have doubtful significance.

Results

It is evident from table 2 that addition of copper produced an extra progressive loss of vitamin C in both raw and pasteurized milk. Copper did not produce a serious immediate loss in the raw milk. This finding is based on the estimated initial vitamin C contents obtained by extrapolating the values in table 2 to the time the copper was added. The losses 2 hours after pasteurization or 3 hours after addition of copper are small relative to the losses on longer storage and indicate the same finding. There probably was an immediate loss on pasteurization after the addition of 0.1 or more p.p.m. of copper. The data are, however, inadequate to distinguish accurately between an immediate loss and a progressive loss whose rate slowed as the vitamin content of the milk diminished. When only 5 p.p.b. of copper were used, the extra loss of vitamin C was evident only after pasteurization and storage for 24 hours.

The tests in table 4 indicate that 5 p.p.b. of copper added to milk produced a decrease of vitamin C in the pasteurized stored milk. This result is confirmed by comparison with the progressively shorter intervals needed to detect the influence of the larger amounts of added copper.

In table 3 the loss due to 1.0 p.p.m. added iron appears to be somewhat more than the minimum significant loss. It is also noteworthy that the extra loss was as evident 2 hours after addition of iron as at any other time and was about equally evident in the raw and the pasteurized milk.

When 100 p.p.b. of iron was added (Table 4), the observed loss of 8% although rather consistent, was hardly more than the experimental error.

Addition of 1.0 p.p.m. of chromium did not produce a significant loss of vitamin C either in the stored pasteurized milk as shown in table 4 or in the raw milk. Tests at intervals of 2 hours and 9 hours after pasteurization did not show greater effects.

The effects of 1.0 p.p.m. added nickel were more pronounced in the pasteurized than in the raw milk. The average effect was as great after 2 hours' storage as after 24 hours' storage. The average effect at both ages appeared to be more than the error of measurement but the effect in different samples of milk varied greatly.

It may be estimated conservatively that compared to copper, at least 20 times as much iron or 200 times as much chromium or nickel are required to produce comparable destruction of vitamin C. The significance of these ratios in choosing materials for pasteurizing equipment is further emphasized by the fact that copper or brass is probably 100 fold more soluble in milk than stainless steel (12). Of the four metals studied copper was the only one for which both pasteurization and storage increased the destructive effect of vitamin C in milk. This fact further substantiates the earlier inference that excessive loss of vitamin C after pasteurization and storage indicates contamination with copper.

III. INFLUENCE OF ADDED COPPER IN THE RATION

Procedure

Although Elvehjem, Steenbock and Hart (14) reported that addition of copper to the ration produced no significant increase of copper in the milk, it seemed worth while to test the effect of the added copper in the ration on the rate of loss of vitamin C in pasteurized milk. Accordingly eight cows were each fed 0.3 gram of copper as copper sulfate solution sprinkled on the ration each evening for four days. Samples of milk from each of these cows and from eight other cows giving milk of approximately equal vitamin C content were collected for 3 milkings following the first copper supplement and again after the fourth supplemental feeding.

Each sample of milk was divided into two parts, one of which was pasteurized at 160° F. for 1 minute. Both parts were analyzed after 2 hours and 24 hours storage at 80° F.

Results

The copper supplement did not at any time produce a detectable difference in the vitamin C content of fresh raw milk or of freshly pasteurized milk. The loss after pasteurizing and storing averaged 30 per cent for the control milk and 49 per cent for the milk produced on the copper supplemented ration. The difference of 19 per cent \pm a standard error of 5.6 per cent indicates a critical ratio of 3.4. In other words, there is less

than 1 chance in 1000 that there is not a real difference between the two groups. The loss is the same order of magnitude as that produced by 5 p.p.b. of copper to the milk. The simplest interpretation of this result is that the increased copper in the ration did slightly increase the amount of copper in the milk.

The amount of added copper in milk needed to produce this effect on vitamin C stability is less than could be detected by chemical methods (11, 14). The deduction, that copper added to the ration produced additional copper in the milk, extends rather than conflicts with the test made by Elvehjem, Steenbock, and Hart. The large increase of copper in the ration needed to produce a barely detectable decrease of vitamin C stability in the milk indicates that normal variations of copper in the ration probably would not produce any significant effect on the vitamin C content of milk.

CONCLUSIONS

Milk, either raw or pasteurized by the short time, high temperature process, but uncontaminated with copper was held 35 hours without serious loss of vitamin C. Such milk may be an important source of vitamin C in human nutrition.

Stainless steel tubular short time high temperature pasteurizers were found to be well suited to the preservation of vitamin C in milk. There was no significant destruction of vitamin C during the pasteurizing process, and very little loss when the milk had been stored 24 hours after pasteurization.

The 30 minute holding process of pasteurization as investigated in five different types of pasteurizers was found not to be well adapted to the preservation of vitamin C in milk. Excessive losses were found even when contamination with copper was reduced to a minimum. The losses were frequently serious during the storage period after pasteurization as well as during the pasteurizing process.

Pasteurized milk to which 5 p.p.b. of copper had been added contained less vitamin C 24 hours after pasteurization than check samples without added copper. The addition of 0.1 p.p.m. of iron or 1.0 p.p.m. of either chromium or nickel to the milk produced less effect than 5 p.p.b. of copper. Only in the case of copper did both pasteurization and storage increase the destructive effect of the added metal.

Addition of 0.3 gram of copper daily to the ration produced a significant decrease in the stability of vitamin C in pasteurized milk and probably produced a corresponding increase in the copper content of the milk. Normal variations of copper in the ration would probably not produce any significant effect on the vitamin C content of milk.

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SOME EFFECTS OF THE PROPOSED NEW BACTERIOLOGICAL TECHNIQUES

JOSEPH F. PHELAN

Laboratories of H. P. Hood & Sons, Inc., Boston, Mass.

In 1910 the A. P. H. A. issued its first pamphlet on "Standard Methods of Milk Analysis." This has been amplified several times, and in 1935 the sixth, or latest edition was published. For some years there has been scattered agitation so to change the standard agar as to give larger colonies and higher counts. Sherman (1), in 1916, and Supplee, Whiting and Downs (2) in 1921 reported improvements by changing the medium. Later, in 1935, Bowers and Hucker (3) after studying several media, reported that the best growth was to be had by using a tryptone glucose skimmilk agar. Pederson and Yale (13) reported to the A. P. H. A. in 1933 their work with 32° C. incubation, wherein they got approximately a 50 per cent increase in count over standard 37° C. temperature.

There has been considerable opposition to proposed changes in agar and incubation temperatures, as evidenced by the report of R. S. Breed (4), who called attention to the necessity of cooling systems in case 30° C. incubators were to be used. J. F. Norton (5) in 1928 reported that higher counts were of minor importance in milk control, rather uniformity was needed. A. H. Robertson (6) in 1921 stated that higher counts on agar plates would not be more uniformly proportionate to the total number present. George E. Bolling (7) in 1932 regretted the suggestion of obtaining higher plate counts, remarking that their incorporation into Health Department records would upset comparisons and shake the confidence of the public in the purity of milk supplies. H. W. Conn (8) in 1915 and Breed and Stocking (9) in 1920 asserted that exact composition of the media and the necessity for absolutely exact counts were overemphasized.

In the report of Bowers and Hucker (3) they state the higher counts on the proposed new agar would not seriously affect producers of high grade milk. However, in the same paper they state the problem of whether it is practical to use the tryptone glucose skimmilk agar for routine counts, as they might affect present standards and work a hardship on producers and dealers unless standards are changed. Now, of course, comes the consideration as to whether or not it would be possible to change Federal, State and Municipal standards of bacteria counts all over the area covered by the A. P. H. A. if any change in media were made. Again in the same bulletin Bowers and Hucker state: "The adoption of this type of agar (tryptone

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glucose skimmilk agar) which would materially increase the counts secured from milk samples also involves certain other practical considerations in the relation of the counts obtained to the standards fixed by present milk grading ordinances. It is evident that if a medium is adopted which increases the counts as obtained in routine milk grading laboratories, the standards fixed for milk grades should be modified, or otherwise producers and dealers will find their milk automatically degraded due to the increased counts found in laboratory analyses."

The composition of the proposed new agar is:

Tryptone	0.5%
Glucose	0.1%
Agar	1.5%
Skimmilk	0.5%
Distilled water	

The new proposed incubation temperature as recommended by Pederson & Yale (10) is 32° C. The question immediately suggests itself as to the ability of analysts to keep the temperature of the ordinary incubator down to 32° (89.6° F.) on hot days in many parts of the country.

EXPERIMENTAL

As these proposed changes are of tremendous importance to the dairy industry, an investigation along these lines concerning bacterial counts due to changes in media composition and incubation temperatures have been carried out by the writer. This investigation included the bacterial examinations of 1962 samples of different dairy products, and the statistical analysis of the results obtained, thereby obtaining comparisons between:

- (a) 37° C. standard agar and 37° C. tryptone skimmilk agar.
- (b) 37° C. standard agar and 32° C. standard agar.
- (c) 37° C. standard agar and 32° C. tryptone skimmilk agar.

These plates were all made between the latter part of August and late December 1935, the low temperature portion having been performed during November and December. The plates used were placed in two types of incubator: (a) water jacketed Board of Health type, gas heated, and (b) transite board, electrically heated. These incubators were used on alternate days, so the whole series of samples represents a cross section. The samples to be designated: "Pasteurized in Laboratory" were in sterile tube vials, heated quickly to 143° F., placed into a thermostatically controlled water bath at 143° F., and held at this temperature for 32 minutes. The tubes were then plunged into ice-water and cooled immediately below 50° F. The "Washed bottles" were quart bottles taken from soaker-type bottle washers. Fifty cc. sterile water were used and one cc. plated. The "Washed cans 40

quart" were taken from a circular-type jet washer. Four hundred cc. sterile water were used and one cc. plated. In the case of ice cream, one cc. rather than one gram, was plated. The samples were all plated in H. P. Hood & Sons Laboratory at Boston, but the samples represent dairy products from entire New England. The agar was all made in our laboratory from Difco products, the pH of the standard agar being approximately 6.7, no correction having been made because none was necessary. The plates were incubated for 48 hours, plus or minus three hours, and comparative plates were always placed in the same incubator and reasonably near by each other. The plates were all counted in the colony counting device of the author (11), giving magnification and illumination as called for in "Standard Methods." All averages quoted are arithmetical.

TABLE 1
Increases in bacterial counts
37° C. standard agar vs. 37° C. tryptone agar. (941 samples)

SAMPLES	AVERAGE 37° C. STANDARD AGAR COUNTS	AVERAGE 37° C. TRYPTONE AGAR COUNTS	PERCENTAGE INCREASE OVER 37° C. STD. COUNTS	NUMBER OF SAMPLES
Grade A Producers' Cans—Raw	18,500	23,000	24	111
Grade A Pasteurized and Bottled	1,800	3,900	116	82
Grade B Tank Cars—Raw	90,800	171,000	88	111
Grade B Tank Cars—Pasteurized in Laboratory	3,140	7,200	129	111
Grade B Producers' Cans—Pas- teurized in Laboratory	3,400	7,290	114	216
Grade B Pasteurized and Bottled	4,900	14,700	200	114
Certified Milk	1,150	1,380	20	33
Cream Shippers' Cans	112,000	265,000	114	103
Washed Bottles	2,410	7,250	200	30
Washed Cans, 40 Qt.	156,000	249,000	88	30

In Table 1 will be found the data from 941 samples during August and September and the incubation temperature was 37° C. in each case. The standard agar counts and the tryptone agar counts are presented as averages of all plates made of each particular type of product, such as Grade A producers cans raw, Grade A milk pasteurized and bottled, etc.

The third column of figures shows the percentages of increase obtained by the use of tryptone agar over the counts of plates made on standard agar from the same samples. It will be seen readily that the better grade products show the smallest percentage increase, for example, Certified milk of little over 1000 bacteria per cc. shows only a 20 per cent increase due to tryptone agar, and Grade A producers' milk 24 per cent increase. On the

TABLE 2
Increases in bacterial counts
37° C. standard agar vs. 39° C. standard and 39° C. tryptone agar. (1021 samples)

SAMPLES	AVERAGE 37° C. STANDARD AGAR COUNTS	AVERAGE 32° C. STANDARD AGAR COUNTS	PERCENTAGE INCREASE OVER 37° C. STD. COUNTS	AVERAGE 32° C. TRYPTONE AGAR COUNTS	PERCENTAGE INCREASE OVER 37° C. STD. COUNTS	NUMBER OF SAMPLES
Grade A Producers' Cans—Raw	7,200	12,100	68	14,500	101	109
Grade A Tank Cars—Raw	11,900	25,000	110	35,440	197	88
Grade A Pasteurized and Bottled	1,123	2,960	163	4,360	288	123
Grade B Tank Cars—Raw	116,070	153,400	32	285,100	122	81
Grade B Tank Cars—Pasteurized in Laboratory	3,919	8,342	113	16,212	311	26
Grade B Producers' Cans—Pasteur- ized in Laboratory	2,680	6,700	150	8,200	206	112
Grade B Pasteurized and Bottled	4,202	8,800	109	24,225	476	119
Certified Milk	1,636	1,708	4	2,008	23	84
Cream Shippers' Cans	51,300	152,000	196	297,200	479	95
Cream Pasteurized and Bottled	52,800	352,400	558	385,500	630	123
Ice Cream	48,019	106,843	122	177,623	269	21

other hand, the Grade B bottled milk pasteurized gives a 200 per cent increase. Grade B milk shows a greater increase than does Grade A. The observation of Bowers & Hucker (3) that, "this is a good medium for growing bacteria in pasteurized milk" is certainly borne out in this table.

In Table 2 are the data obtained during October, November and December on 1021 samples of dairy products, comparing the 37° C. standard agar with both the 32° C. standard agar and the 32° C. tryptone agar. Here some very startling increases in bacteria count are evident. The first column of figures, 37° C. standard agar counts, show what might be called average bacteria counts in most cases, and with one or two exceptions the 32° C. standard agar count does not appear much higher than did the 37° C. tryptone count from the previous table. Cream pasteurized and bottled jumps rather alarmingly from 52,000 to 352,000 or an increase of 558 per cent, but Certified milk and Grade A milk, as in the previous table, are low.

With the combination of tryptone agar and 32° C. incubation tremendous increases result. The anchor, however, still seems to be Certified milk, which shows an increase of only 23 per cent, where all of the other types of product show serious percentage increases over 37° C. standard agar. Grade B milk shows a 476 per cent increase and bottled cream 630 per cent. Even Grade A milk bottled shows the startling increase of 288 per cent in this technique over the 37° C. standard agar. At this point it might be well to refer again to Bowers and Hucker (3) who state that the adoption of this agar would not materially affect dealers who handle really high grade pasteurized milk. Certainly increases in counts in Grade B milk of 200, 109 and 476 per cents are very serious bacterial increases and might materially affect dealers in those areas where bacteria counts are published.

TABLE 3

Percentage of cases where the 37° C. tryptone agar count exceeded the 37° C. standard agar count. (941 samples)

INCREASE IN COUNT	GRADE A PRODUCERS' CANS RAW	GRADE A PAST. AND BOTTLED	GRADE B PAST. AND BOTTLED	CREAM SHIPPERS' CANS PAST.	CERTIFIED MILK
	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>
Over 50	39	42	77	94	15
" 100	23	22	52	84	6
" 200	10	11	30	63	3
" 300	4	7	22	44	3
" 400	2	2	19	36	1
" 500	2	2	16	28	1
" 1,000	1	1	6	15	0
" 4,000	0	0	1	5	..
" 8,000	...	..	0	0	..

TABLE 4
Percentage of cases where the 32° C. standard agar count exceeded the 37° C. standard count. (1021 samples)

INCREASE IN COUNT	GRADE A PRODUCERS' CANS RAW	GRADE A PAST. AND BOTTLED	GRADE B PAST. AND BOTTLED	GRADE B CANS RAW	GRADE B PAST. AND BOTTLED	CREAM SHIPPERS' CANS PAST.	CREAM PAST. AND BOTTLED	CERTIFIED MILK	ICE CREAM
per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent
Over 50	45	58	69	40	58	73	96	21	66
" 100	19	45	53	26	39	53	91	12	43
" 200	6	27	38	8	20	20	79	9	14
" 300	3	22	26	3	12	13	78	7	9
" 400	1	18	18	1	9	6	70	3	9
" 500	0	12	13	0	6	6	63	2	9
" 1,000	...	7	3	...	2	6	48	1	4
" 4,000	...	0	0.8	...	0	0	20	0	0
" 8,000	...	...	0	...	...	...	10	...	...
" 10,000	...	...	...	...	...	...	9	...	...
" 20,000	...	...	...	...	...	...	2	...	...
" 40,000	...	...	...	...	...	...	0.8	...	...
" 80,000	...	...	...	...	...	...	0.8	...	...
" 100,000	...	...	...	...	...	...	0	...	...

In Table 3 the same picture is presented from a different angle. This has reference again to the 941 samples examined on the two types of agar at 37° C. and shows the percentage of the samples analyzed giving various increases in count over the 37° C. plates. Considering the "Certified" column first, it will be noted that an increase in count of over 50 per cent was obtained in only 15 per cent of the cases, and going down the column we find that 1 per cent of the cases had an increase of over 500 per cent. However, the second-last column shows that in 94 per cent of all the cream samples analyzed an increase in count of over 50 per cent was obtained, and a high percentage of samples persisted as we proceed down the next left-hand column as far as a 4,000 per cent increase which occurred in 5 per cent of the samples tested. A similar picture may be observed from the Grade B pasteurized data, and to a lesser extent from that of the Grade A pasteurized milk.

In Table 4 may be found the same kind of data, setting forth the 1021 samples plated with the 32° C standard agar against the 37° C. standard agar. This picture is not unlike the previous one, except that in the case of cream a new column, "cream pasteurized and bottled" has been added. Now the increases are getting up into high figures, for in almost one per cent of the samples tested an increase in count of over 80,000 per cent was obtained. In one of these cases bottled cream gave 700 bacteria per cc. at 37° C. and 600,000 bacteria per cc at 32° C. Some other tremendous differences obtained in the same way were: 3,800 vs. 480,000, 13,200 vs. 1,700,000, and 4,000 vs. 1,000,000.

Table 5 is again similar to the previous tables, showing the occurrence of increased counts in the case of the 32° C. tryptone plates as against the 37° C. standard plates. It is obvious that the percentages are higher in nearly every case, and sharply higher in many cases. Grade A producers' cans, for instance, show an increase of from 45 to 68 per cent, Grade B tank cans from 40 to 84 per cent, Cream cans from 73 to 92 per cent, and Certified Milk from 21 to 40 per cent. This demonstrates the combined effect of lower incubation temperature and tryptone agar.

SUMMARY

In Table 6 is shown the fact that in this work a considerable number of the samples tested were sufficiently higher in count with tryptone agar to bring them into the class of illegal milk in Massachusetts. The same also applies to 32° C. incubation. It is conceivable that should such increases in count actually occur as a result of the proposed new methods, serious losses in milk consumption might result due to lack of public confidence in the quality of dairy products.

TABLE 6

City of Boston average counts June 1 to Dec. 1, 1935, and their relationship to counts obtained under proposed new techniques

	MARKET MILK	GRADE A MILK
City of Boston counts—standard agar	11,600	3,300
Massachusetts state standard	40,000	10,000
Increase in city of Boston milk counts required to exceed state standard	245%	203%
Percentage of cases these increases occurred in this experiment:		
In 37° C. tryptone agar	26%	11%
In 32° C. standard agar	16%	38%
In 32° C. tryptone agar	60%	53%

It is important to observe that if these proposed methods be adopted, there is no assurance other methods for obtaining higher counts shall not be proposed at a later date. With such increases in counts as produced by changes in method, public and private bacteriological records might be confused for years.

It has been suggested that health departments might change their bacteriological standards to meet these proposed changes in technique. The writer is skeptical as to the probability of many health departments actually doing this, and if changes in standards were accomplished, it seems that these changes would lack uniformity.

Unless such proposed new methods can be shown without question to have a bearing on the health of the consumer, their adoption should proceed with the highest degree of caution.

CONCLUSIONS

1. Greater numbers of bacterial colonies may be demonstrated from samples of milk products by tryptone glucose skimmilk agar and 32° C. incubation than by the use of the present standard technique.

2. Using these changes in technique, the changes in count in some types of dairy products, as compared with the present standard method, have been tremendous—in certain instances variations of over 80,000 per cent having been noted.

3. Any change in existing standard methods should be adopted by the Committee on Standard Methods of Milk Analysis, only after the most extensive investigation concerning their adaptability by the entire industry.

4. Changes of this nature should be considered only if and when provision for proper bacterial standards for milk and milk products, based upon such new methods, have been developed, and if and when means have been

provided for regulatory agencies to make proportionate, uniform, and simultaneous changes in existing bacteria standards.

ACKNOWLEDGMENT

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CURD TENSION OF MILK AND ITS RELATIONSHIP TO FIRMNESS OF CURD IN CHEESEMAKING

G. P. SANDERS, K. J. MATHESON AND L. A. BURKEY

Bureau of Dairy Industry, U. S. Department of Agriculture, Washington, D. C.

In experiments conducted in these laboratories on the manufacture of Swiss cheese it has been found desirable to measure the curd firmness of the kettle milk for the purpose of determining the effects of this and other related factors upon the quality of the cheese. Preliminary work has shown that when milk to be used in cheesemaking is selected on the basis of curd firmness, the use of soft-curd milk causes the cheese to have a relatively soft texture and to contain a high percentage of moisture, while the use of hard-curd milk causes the cheese to have a relatively firm and dry curd. The present work was conducted for the purpose of developing suitable tests for determining the curdling properties of milk to be used in the manufacture of cheese. In addition to the economic value of this work, an analysis of certain factors which cause variations in curd firmness is of particular scientific interest.

Allemann and Schmid (1) measured the rennet curd tension of milk and stated that the use of firm-curd milk markedly increased the firmness and decreased the whey-holding capacity of cheese curd, resulting in the curd-splitting or "glaesler" defect and causing the cheese to ripen slowly because of a deficiency of fermentable constituents for bacterial growth. They stated that the use of soft-curd milk caused the retention of a large amount of whey and the cheeses were soft and tended to flatten on the shelves; the curd was high in acidity, the ripening was abnormally rapid, and the eyes were overdeveloped, unclean, and irregular in shape. Price (9) and Hill and Merrill (6) found firm-curd milk more satisfactory than soft-curd milk for making Cheddar cheese.

The device used by Alleman and Schmid for measuring rennet curd tension was similar in principle to that used later in the Hill (5) curd test, although it differed somewhat in design. In the Hill curd test, which is the test commonly used by most workers in recent experiments, the coagulant used contains pepsin and calcium chloride; due to the addition of the latter reagent, the coagulated mixture contains approximately three times as much calcium as is contained in normal milk and the pH is reduced from about 6.6 to about 5.7. Largely because of the changes produced in the milk by this increase in the calcium content and the resulting change in hydrogen-ion concentration, some doubt has recently been expressed (7) (8) as to the

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validity of curd-tension data secured in tests in which the Hill reagent is used.

PROCEDURE

In the present work about 300 samples were tested, but although all data are included in the calculations, only the average figures are presented. The milk of each cow in a herd was tested twice, about 3 months intervening between each series of tests. The milk used, that produced by each cow in one day, was held at a temperature of 5° to 8° C. until tested, to eliminate the factor of significant bacterial growth after milking. The samples were tested within 4 or 5 hours after the morning milking.

The Hill curd test was carried out in the manner described by Hill (5). The percentage of casein was determined by the Walker (formol titration) method. All tests were made in duplicate, and no difficulty was encountered in obtaining satisfactory duplicate results.

In determining firmness of rennet curd, the procedure used in the manufacture of Swiss cheese was followed in every detail with the exception that the process was carried out on a small scale, 500 cc. of milk being used in each test. The temperature was 33° C. and the concentration of rennet extract in the milk was 0.018 per cent. The final firmness of the curd under these conditions was judged by manual examination during the cheese-making process and was scored on a scale of 10 to 130 (10, very soft; 130, very firm). The rennet coagulation time, under the above conditions, was also recorded.

A rapid and accurate procedure was developed for determining rennet coagulation time, as follows: 5 cc. of commercial rennet extract were made up to 250 cc. in water. The solution was mixed, warmed to 35°, and held at that temperature. Samples of milk containing 100 cc. were placed in 8-oz. bottles, the contents were warmed to 35°, and the bottles were placed in a water bath which was fitted with a 500-watt heater, a thermostat set to maintain the temperature at exactly 35°, and an air-driven stirrer. Five cc. of the rennet solution were added to each 100 cc. milk sample and the contents were mixed and allowed to syphon out through an inverted U-shaped capillary tube, dropping upon the inner surface of a tilted beaker. The time from the addition of rennet to the first appearance of a coagulation or flocculence was recorded as the coagulation time.

The rennet curd tension was determined at a temperature of 35° and with a rennet concentration of 0.018 per cent; the technique was the same as that used in the Hill curd test except that only rennet extract was used as the coagulant and the time allowed for the formation of curd was 45 minutes instead of 10 minutes. Five cc. of rennet extract were made up to 275 cc.

in water and 1 cc. of this solution was mixed with 100 cc. of milk. The measurements were made with the Curd-O-Meter (Hill curd tester).

In carrying out the alcohol test, 4 cc. of milk and 9 cc. of 78 per cent ethanol were mixed at 25° in a 15 cc. graduated centrifuge tube; the tubes were allowed to stand in a water bath at 35° for 30 minutes, and were then centrifuged for 10 minutes in a Babcock tester fitted with special centrifuge tube holders. The volume of precipitate in each tube, as read on the graduated scale on the tube, was recorded.

RESULTS

The data in Figure 1 show a striking lack of agreement between the Hill curd tension and the firmness of rennet curd. The minimum and maxi-

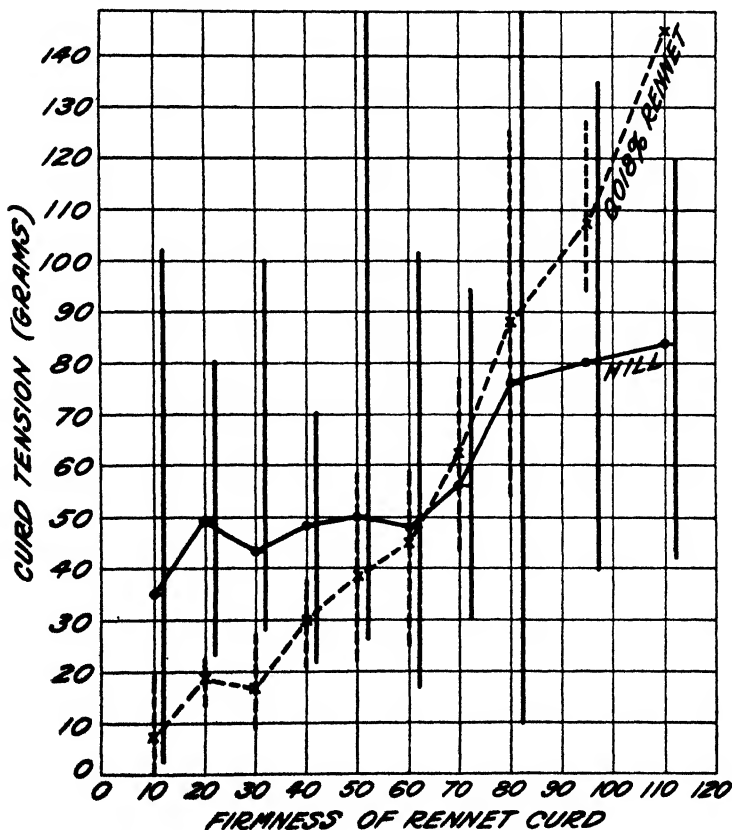


FIG. 1. Relationship between firmness of rennet curd and curd tension (points on curves indicate averages of values; vertical lines indicate ranges of values).

imum values, indicated by the heavy vertical lines, emphasize this lack of agreement. For example, a milk of which the numerical value for firmness of rennet curd is 10 may have a Hill curd tension varying between 3 and 102. The rennet curd tension, however, shows a comparatively much closer correlation to the firmness of rennet curd than does the Hill curd tension, not only from the standpoint of average values, but also in minimum and maximum values.

It was found that the rennet curd tension values of different milks vary over a wider range than do the Hill curd test values. In many instances milks which show large differences in rennet coagulability show only slight or negligible differences in Hill curd test values; moreover, some milks which would be classed as hard-curd milks by the Hill curd test are coagulated only very slowly by rennet.

When the data for firmness of rennet curd were plotted against data for rennet coagulation time, as determined by two different methods and indicated in Figure 2, satisfactory correlations were obtained. The minimum

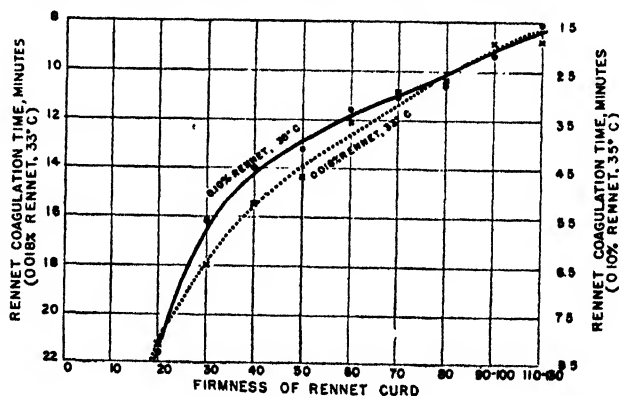


FIG. 2. Relationship between firmness of rennet curd and rennet coagulation time determined by two different methods.

and maximum values did not vary greatly from the average values, hence the rennet coagulation time may be used as a fairly satisfactory measure of firmness of rennet curd. However, as has been pointed out by Allemann and Schmid (1) and later by Bendixen (2), the two are not in all cases strictly proportional. The results indicate that, in milks in which the rennet curd is very firm, the coagulating efficiency of the larger amount of rennet (0.10 per cent) is relatively great, while in soft-curd milks the rate of curdling is more nearly proportional to the amount of rennet added, under the conditions shown. The coagulation time was in all cases abnormally long when the value for firmness of rennet curd was 20 or less.

The data in Figure 3 show that the rennet curd tension, measured in grams by means of the Curd-O-Meter, bears a definite relationship to the firmness of rennet curd in the cheese-making process.

There is a rather indefinite correlation between the rennet curd tension and the results of the alcohol test. The experimental data have shown con-

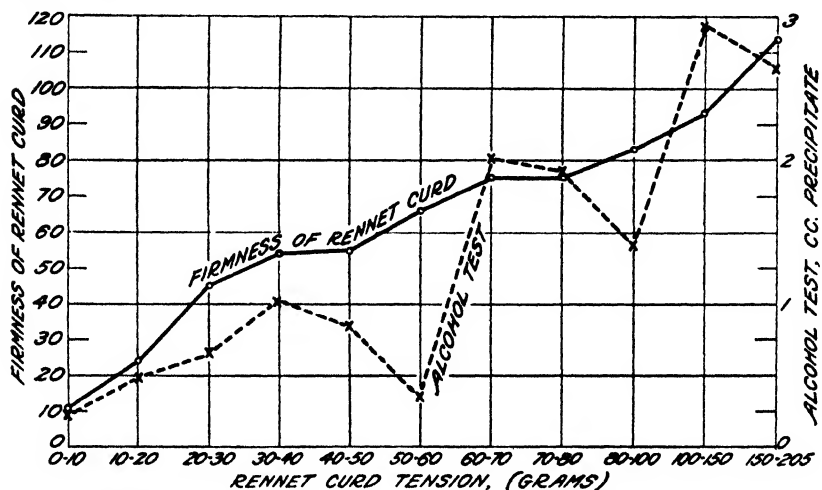


FIG. 3. Relationship between rennet curd tension and (1) firmness of rennet curd, and (2) alcohol test.

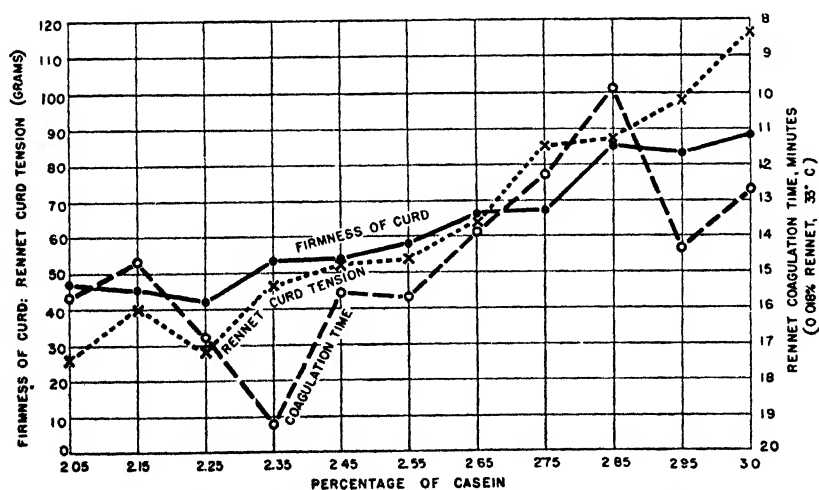


FIG. 4. Relationship between percentage of casein and (1) firmness of rennet curd, (2) rennet curd tension, and (3) rennet coagulation time.

clusively that most milks having relatively low rennet curd tensions are more stable to alcohol than those which produce firm rennet curds. Doan and Welch (4) found no consistent relationship between Hill curd tension and alcohol stability.

The percentage of casein was found to have a very indefinite relationship to the rennet coagulation time. It is shown in Figure 4 that the percentage of casein has a greater influence on the rennet curd tension and upon the firmness of rennet curd in the cheese process than upon the rennet coagulation time. An examination both of the averages of data, shown in

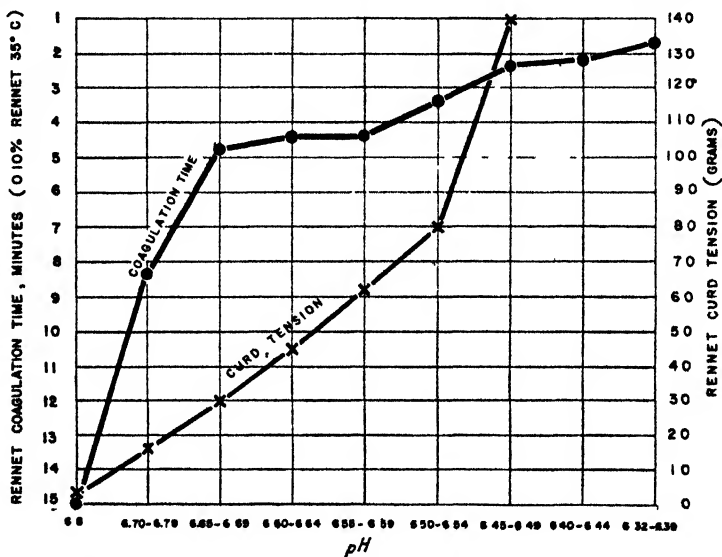


FIG. 5. Relationship between pH and (1) rennet coagulation time, and (2) rennet curd tension.

Figure 5, and of other data secured from tests on many individual samples of milk indicates that the pH is a major factor in determining the rennet coagulation time, while the percentage of casein is relatively more important as a factor in influencing the rennet curd tension. Correlations made on a large number of tests show that Hill curd test values are influenced to some extent by the original pH values of milk samples. However, the effect of pH is much more pronounced upon rennet curd tension and especially upon rennet coagulation time than upon Hill curd test values.

The influence of pH upon coagulation time seems to be most marked when the pH is above 6.65; the influence of pH upon curd tension seems to be most marked when the pH is below 6.50; the percentage of casein influences the curd tension at every point in the range of casein content.

Among 294 milk samples, the highest pH value was 7.45, the lowest 6.32, and the average 6.60. The weighted average pH, however, was slightly below 6.60, since the milks of many of the high-producing cows had relatively low pH values.

In addition to the results reported above, it was found that the rennet coagulation time was increased and the rennet curd tension decreased when milk was stored for from a few hours to three days at temperatures of 2° to 5°. Bendixen (2), working independently, showed that storage of milk to which an antiseptic has been added causes a decrease in the rennet coagulation of the milk, while Berry (3) and others (4) have shown that the Hill curd tension of milk is not changed by storage. Further experiments showed that stability to alcohol was increased when milk was stored and that alcohol stability, like rennet stability, was decreased by the addition of CaCl_2 .

The effect of the homogenizing process in decreasing the Hill curd tension of whole milk has been shown by Theophilus and his coworkers (10) and by Doan and Welch (4). Bendixen (2) found that homogenization of skim milk caused no decrease in the firmness of rennet curd and no increase in rennet coagulation time, and Doan and Welch have shown that homogenization causes no decrease in the Hill curd tension of skim milk. The data shown in Table 1 indicate that homogenization of whole milk causes a marked softening of the rennet curd without changing the rennet coagulation time, and that homogenization of skim milk has no effect upon rennet curd tension or rennet coagulation time. These results indicate that the curd-softening effect of homogenization is probably due entirely to the

TABLE 1
Effect of skimming, pasteurizing, and homogenizing on the rennet curd tension and coagulation time of milk

SAMPLE NO.	1		2	
	Rennet curd tension	Rennet coagulation time	Rennet curd tension	Rennet coagulation time
	<i>g.</i>	<i>min. sec.</i>	<i>g.</i>	<i>min. sec.</i>
Whole milk, untreated	39 ¹	3 33	73 ²	2 20
Skimmed milk . .	56	3 58	91	2 28
Whole milk, pasteurized ³	36	3 43	58	2 25
Whole milk, pasteurized and homogenized ⁴	15	3 42	24	2 24
Skimmed milk, homogenized ⁴			90	2 28

¹ Percentage of fat in milk, 4.3; ² 2.8.

³ Pasteurized at 62.5° C. for 30 minutes.

⁴ Homogenized at 2,000 pounds pressure.

action of the process in causing an increase in the dispersion of the fat globules and thus hindering the subsequent aggregation of the casein micellae; Doan and Welch arrived at the same conclusion in work which differed from ours in that the Hill reagent was used as the coagulant. As further evidence in support of this assumption, it is shown in Table 1 that the rennet curd tension of whole milk is considerably lower than that of the same milk after separation, although the rennet coagulation time is not decreased by the removal of the fat.

The data in Table 1 also show the combined effect of homogenization and pasteurization in reducing the rennet curd tension of whole milk. The effect of homogenization is evidently much greater than that of pasteurization, although the latter process has an appreciable curd-softening effect, which, according to Bendixen (2), is proportional to the temperature used.

In studying relationships between mastitis and physical properties of milks, the following tests were used as evidences of mastitis: the presence of streptococci from the udder, strip cup test, pH, catalase test, and leucocyte count. The average data obtained in tests on 309 samples of milk are shown in Table 2. While the average rennet curd tension was relatively low and

TABLE 2
Effects of mastitis on properties of milk (average values)

	CASEIN ¹	pH	RENNET COAGU- LATION TIME		RENNET CURD TENSION	NUMBER OF TESTS
	%		min.	sec.	g.	
Holstein: mastitis . . .	2.33	6.66	5	42	31	64
non-mastitis . . .	2.28	6.53	3	30	57	68
entire group . . .	2.32	6.59	4	18	39	188
Jersey: mastitis . . .	2.90	6.65	5	36	93	31
non-mastitis . . .	2.69	6.49	2	30	109	55
entire group . . .	2.81	6.56	3	30	98	121

¹ Determined by the formol titration method.

the coagulation time was long in the mastitis milk, the average percentage of casein as determined by the formol titration method was actually slightly higher in mastitis milk than in normal milk. The above evidence as to percentage of casein may not be considered as conclusive, however, since the formol titration method is considered accurate for estimating amino groups rather than casein, and may be properly used for estimating the percentage of casein only in milk of normal composition. There is a reasonable doubt whether mastitis causes as great a decrease in percentage of casein as has been generally believed. In further work now under way preliminary to a

more detailed study of the effects of mastitis upon milks, analyses of samples from each quarter of mastitis-infected udders have shown in some cases a decrease and in some cases an increase in percentage of casein, as determined by the official method, in mastitis milks as compared with normal milks.

In order to consider the changes which took place during an elapsed time of three months, as a result of mastitis, data were tabulated from tests of samples from those cows which either acquired mastitis during this period or which showed increased symptoms of the disease. On this basis it was found that the presence of mastitis was accompanied by a distinct increase in the pH values of the milks, and increase in the rennet curdling time in 96 per cent of the milks, and a reduction in the firmness of rennet curd in 60 per cent and in the Hill curd tension in 56 per cent.

The cows showing evidences of chronic mastitis produced milk of high pH value, long curdling time, and soft curd. There was a tendency for the properties of mastitis milks to return to normal when the bacteriological and pathological evidences of the infection subsided. Some soft-curd milks were found in which no evidences of mastitis were present.

SUMMARY

In experiments on over 300 samples of milk the following observations were made:

The Hill curd test was found not satisfactory for determining the firmness of curd in milk to be used for making cheese. The rennet curd tension as measured by means of the Hill Curd-O-Meter was entirely suitable for this purpose, and the determination of rennet coagulation time was fairly satisfactory.

The pH values of milks bore a very definite relation to the rennet coagulation time and to the rennet curd tension, and bore a less definite relation to the Hill curd tension. The pH seemed to be a major factor in influencing the rennet coagulation time, while the percentage of casein was found to be more important in influencing the rennet curd tension.

Milks stable to rennet were usually stable to alcohol. Stability to both rennet and alcohol was increased when milk was stored at 2° to 5° C. for from a few hours to several days. Stability to both rennet and alcohol was decreased by the addition of CaCl_2 .

Homogenization markedly decreased the rennet curd tension of whole milk but did not change that of skimmilk; this process did not change the rennet coagulation time of either whole or skimmilk. Removal of milk fat by separation increased the rennet curd tension and caused a slight increase rather than a decrease in the rennet coagulation time. These observations lead to the conclusion that the curd-softening effect of homogenization is due principally to an increase in the dispersion of the fat, the dispersed fat

acting as a physical hindrance to the aggregation of the casein molecules and micellae.

Pasteurization caused a noticeable softening of milk curd and caused a slight increase in rennet coagulation time.

The presence of mastitis caused an increase in pH, an increase in rennet coagulation time, and a decrease in rennet curd tension.

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THE EFFECT OF EARLY BREEDING UPON THE MILK ENERGY PRODUCTION OF GRADE AND PUREBRED TOGGENBURG GOATS

O. C. CUNNINGHAM AND L. H. ADDINGTON

*Department of Dairy Husbandry, New Mexico Agricultural Experiment Station,
State College, New Mexico*

Goats are destined perhaps to be used more and more in fundamental research problems. They are the smallest animals from which milk and milk fat records may be determined directly and with convenience. They are ruminants. In so far as feed cost is concerned, five to six or seven does may be maintained for the same cost as one cow. The length of the lactation period is about the same as that for dairy cows. The number of generations of females, as well as the total number of females, that can be produced in a given time is greater with goats than with cattle, because of the frequency of twins and triplets in goats and the fact that females born with males will breed in the case of goats.

Addington and Cunningham (1) found that Toggenburg does over 18 months of age at parturition produce offspring at the rate of about 2,100 kids for each 1,000 pregnancies, and that yearling does, under 18 months of age at parturition, produce offspring at the rate of about 1,500 kids per 1,000 pregnancies.

Goats may be bred to kid the first time at 12 or 13 months of age and again at the age of two years. If this practice could be followed without detrimental effect upon the does, the number of generations of animals that could be raised in a given period would be materially increased. However, many goat breeders have insisted that the does should not be bred to kid for the first time until they are at or near two years of age.

EXPERIMENTAL RESULTS

The published records of twenty-two pairs of full sisters are available in the appendix of (1), pp. 78 to 80, inclusive, and furnish the material for the discussion in this study.

One member of each pair of these twenty-two pairs of full sisters kidded for the first time at or near two years of age. The other member of each pair kidded for the first time when between 11 and 14 months of age and again at or near two years of age. The milk and fat produced by the two members of each pair were converted to the equivalent amount of 4% milk as calculated by the formula of Gaines and Davidson (3), (5).

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TABLE 1

A comparison by student's method of the amounts of 4% milk produced by the members of 22 full sister pairs of purebred and grade Toggenburg does in lactations begun at or near two years of age

- (1) Production of 4% milk by does freshening for first time at two years of age.
 (2) Production of 4% milk by does freshening as yearlings and again at two years.

HERD NOS. OF PAIRS	(1) 4% MILK	(2) 4% MILK	D OR 1-2	D ² OR (1-2) ²
	<i>pounds</i>	<i>pounds</i>		
37-36	927.9	1630.0	- 702.1	492,944.4
37-20	927.9	814.5	113.4	12,859.6
170-104	1039.8	1022.4	17.4	302.8
172-111	906.5	1314.5	- 408.0	166,464.0
173-111	892.9	1314.5	- 421.6	177,746.6
31-16	1172.0	902.4	269.6	72,684.2
31-30	1172.0	1180.9	- 8.9	79.2
43-100	827.5	1211.1	- 383.6	147,149.0
121-264	1181.0	1021.7	159.3	25,376.5
34-35	1132.5	921.5	211.0	44,521.0
53-112	1119.8	1400.0	- 280.2	78,521.0
304-303	1394.3	1220.6	173.7	30,171.7
29-12	851.5	1216.3	- 364.8	133,079.0
29-18	851.5	1043.9	- 192.4	37,017.8
29-28	851.5	1435.9	- 584.4	341,523.4
24-21	905.3	957.6	- 52.3	2,735.3
24-25	905.3	1066.3	- 161.0	25,921.0
32-33	786.5	1374.3	- 587.8	341,523.4
23-19	1148.1	945.3	202.8	41,127.8
167-109	1206.4	1240.2	- 33.8	1,142.4
307-306	1565.6	1346.2	219.4	48,136.4
307-422	1565.6	1427.1	138.5	19,182.3
Total ..	23331.4	26007.2	- 2675.8	2,244,185.2
Means .	1060.5	1182.1	- 121.6	102,008.4

$$S. D. = \sqrt{102,008.4 - (-121.6)^2} = 293.3$$

$$\frac{M}{S. D.} = Z = \frac{-121.6}{293.3} = -.415.$$

$$\text{Odds} = 26.8 : 1$$

The data for twenty-two pairs of full sisters have been compared by Student's Method (4) as shown in table 1. The first column in this table gives the herd numbers for the two full sisters of each pair. The second column shows the production of 4% milk for the member of each pair that freshened for the first time at or near two years of age. The third column shows the production of 4% milk by the member of each pair that kidded for the second time at or near two years of age. The fourth column shows the difference between the second and third columns, while the fifth and last column shows the squares of the differences given in column four.

The mean production of 4% milk for the does freshening for the first time at or near the age of two years was 1060.5 pounds, and that for the does freshening for the second time at or near two years of age was 1182.1 pounds. The Z value was found to be $-.415$, which for twenty-two pairs gives odds of 26.8:1 that there is a significant difference between the production of the two groups of does in favor of those that freshened for the second time at or near two years of age.

Either one or both members of 17 of the 22 pairs of does were disposed of, so that records when freshening at or near three years of age for only

TABLE 2

A comparison by student's method of the length of the lactation periods of the members of twenty-two full sister pairs of purebred and grade Toggenburg does in lactations begun at or near two years of age

(1) Days of lactation of does freshening first time at two years of age.

(2) Days of lactation of does freshening as yearlings and again at two years of age.

HERD NOS. OF PAIRS	(1) DAYS	(2) DAYS	D OR 1-2	Σ^2 OR (1-2) ²
37-36	292	297	13	169
37-20	292	218	74	5,476
170-104	247	256	-9	81
172-111	279	292	-13	169
173-111	254	292	-38	1,444
31-16	292	237	55	3,025
31-30	292	296	-4	16
43-100	309	258	51	2,601
121-246	262	304	-42	1,764
34-35	269	293	-24	576
53-112	310	275	35	1,225
304-303	305	309	-4	16
29-12	293	290	3	9
29-18	293	222	71	5,041
29-28	293	295	-2	4
24-21	299	264	35	1,225
24-25	299	297	2	4
32-33	295	294	1	1
23-19	285	230	55	3,025
167-109	271	280	-9	81
307-306	305	305	0	0
307-422	305	305	0	0
Total	6,341	6,091	250	25,952
• Mean	288	277	11	1179.6

$$S. D. = \sqrt{1179.6 - (11)^2} = 32.5.$$

$$Z = \frac{M}{S. D.} = \frac{11}{32.5} = .34$$

$$\text{Odds} = 13.26: 1.$$

5 of the pairs are available for further comparison. The mean production of 4% milk for the 5 does freshening for the second time, at the approximate age of 3 years, was 1453.8 pounds; while that for the 5 does freshening for the third time, at approximately 3 years of age, was 1570.1 pounds. The *Z* value was $-.419$, but since there were only 5 pairs, the odds by Student's Method are 3.46:1 that the difference was significant. While the difference is certainly not a significant one, it is in favor of the does freshening as yearlings, 2-year-olds, and again as 3-year-olds.

Except for three does that were milked for slightly longer periods, the lactation period for each of the does was continued until the goat was dry or practically so, or until 305 days were reached. The data for the length of the lactation periods were analyzed by the use of Student's Method (4) as shown in Table 2. The mean lengths of the lactation periods at two years of age were 288 and 277 days, respectively, for the does freshening for the first time at or near two years of age and those freshening for the second time at or near two years of age. The odds are 13.26:1 that the difference between the lengths of the lactation periods is significant. Odds of 25 to 30:1 are required to establish a definite difference.

Practically all of the does in this experiment that freshened at or near one year of age were milked for a comparatively short lactation period, usually five to seven months, following the earlier kidding. Thus, a comparatively long period between the first and second kidding was allowed for growth, unhampered by lactation. Dr. Eckles (2) has pointed out that the production of milk is a much more severe drain upon an animal's system than is the growth of a foetus.

SUMMARY AND CONCLUSIONS

The production of 4% milk and the length of the lactation period following a freshening at or near two years of age have been compared for twenty-two pairs of full sisters of grade and purebred Toggenburg milk goats. One member of each pair freshened for the first time at or near two years of age and the other member of each pair freshened at or near one year of age and again at or near two years of age.

The odds, by Student's Method, of 26.8:1 are in favor of the does that freshened as yearlings and again as two-year-olds. While the odds are not great enough to show a very significant difference, the tendency is to favor the does that freshened for the second time at or near two years of age. This is in direct contrast to the belief held by a large number of goat breeders.

The mean difference in the length of the lactation period was eleven days and was in favor of the does that freshened for the first time at or near two years of age, with odds of 13.26:1 that the difference is significant. Again

the odds are not great enough to show a definitely significant difference, but the tendency is to favor the does freshening for the first time at or near two years of age.

Under the conditions of this experiment, it is feasible to increase the number of generations of female goats that can be secured in a long-time breeding experiment by having the does freshen for the first time when eleven to fourteen months of age, at least when no attempt is made to milk the yearlings for a full lactation period of ten months.

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American Dairy Science Association Announcements

AMERICAN DAIRY SCIENCE ASSOCIATION

The Thirty-first Annual Meeting

State College, Pennsylvania, June 15-19, 1936

GENERAL PROGRAM

Monday, June 15

1 P. M.-9 P. M. General Registration and room registration, Dairy Building.

Tuesday, June 16

8 A. M.-9 P. M. General Registration and room registration, Dairy Building.
9 A. M.-12 NOON Dairy cattle judging conference.

DEMONSTRATION

Dairy type and milk production in relation to ante-mortem and post mortem weights and measurements.

Palpation of calf udders to demonstrate the various stages of development of the mammary gland. W. W. Swett, Bureau of Dairy Industry, U. S. Department of Agriculture, assisted by members of the Penn State dairy staff.

12 NOON-1 P. M.

Lunch hour.

1 P. M.-4 P. M.

Extension Section Meeting, Room 117, Dairy Building.

1:30 P. M.-4:30 P. M.

Ice Cream Judging Conference, Room 120, Creamery Building.

William White, Chairman, Bureau of Dairy Industry.

A. C. Dahlberg, Judge, New York Agricultural Experiment Station, Geneva.

4 P. M.

Board of Directors' Meeting, Room 209, Dairy Building.

7:30 P. M.

Opening Session, College Auditorium, Central Campus.

President H. A. Ruehe, presiding.

Address of Welcome:

Dr. R. L. Watts, Dean of the School of Agriculture, and Director of the Experiment Station.

Address by the President of the Association.

Dr. H. A. Ruehe, University of Illinois.

Business.

- 8:30 P. M. Informal social get-together for members, guests and their families, 2nd floor lounge, Old Main Building, Central Campus.

Wednesday, June 17

- 8 A. M.-12 NOON General Registration and room registration, Dairy Building.
- 9 A. M.-4 P. M. Complimentary mountain tour for wives, young folks, and children of registrants. See the mountain laurel in bloom and visit Alexander Caverns. Standard buses will provide safety and comfort. Luncheon at Greenwood Forest Camp. Tickets at registration. Assemble in front of Dairy Building.
- 8 A. M.-9 A. M. Sectional Committee Meetings.
 Production, Room 8, Dairy Building.
 Manufacturing, Room 110, Home Economics Building, East Campus.
 Committee on chemical methods for the analysis of milk and dairy products, Rooms 3 and 4, Dairy Building.
- 9 A. M.-12 NOON General Session, College Auditorium, Central Campus.
 President H. A. Ruehe, presiding.
 National Survey of Sediment Testing of Cream and Butter.
 G. F. Stewart and M. E. Parker, Research Committee, American Association of Creamery Butter Manufacturers.
 Science and Practical Dairying.
 W. J. Fraser, University of Illinois.
 Making Research Pay in the Dairy Business.
 J. L. Kraft, President, Kraft-Phenix Cheese Corporation, Chicago.
 Notice: MEN Wanted.
 W. V. Dennis, Professor of Rural Sociology, The Pennsylvania State College.
 Business.
- 12 NOON-1 P. M. Complimentary Dairy Lunch, 120 Creamery Building.
- 1 P. M.-4 P. M. Production Section, Room 8, Dairy Building.
- 1 P. M.-4 P. M. Manufacturing Section, Room 110, Home Economics Building, East Campus.
- 4 P. M.-5 P. M. Sectional Committee Meetings.
 Production, Room 8, Dairy Building.
 Manufacturing, Room 110, Home Economics Building, East Campus.
 Extension, Room 117, Dairy Building.

- Committee on chemical methods for the analysis of milk and dairy products, Rooms 3 and 4, Dairy Building.
- 4 P. M.-5 P. M. See places of interest on the campus.
Respiration calorimeter for large animals.
Jordan Fertilizer Plots (oldest in America).
Mineral Industries exhibit.
Staff members of the departments concerned will be present at the points of interest during this period.
- 6:30 P. M. Complimentary dinner for registrants and their wives, McAllister Hall. Tickets at registration.
- 6:30 P. M. Complimentary dinner, under supervision, for young folks and children, Sandwich Shop, Old Main. Tickets at registration.

Thursday, June 18

- 8 A. M.-10 A. M. Extension Exhibits, Room 201, Dairy Building.
- 9 A. M.-12 NOON Production Section, Room 8, Dairy Building.
- 9 A. M.-12 NOON Manufacturing Section, Room 110, Home Economics Building, East Campus.
- 9 A. M.-12 NOON Children and young folks program.
Supervised play, municipal playground, or mountain hike for those who prefer it. Assemble in front of Old Main Building.
- 10 A. M. For ladies—Places of interest on the campus.
Old Main Tower.
Home Economics Building.
Mineral Industries Exhibits.
Rose Gardens adjacent Dairy Building.
Golf for those who prefer it.
- 12 NOON-1 P. M. Lunch hour.
- 1 P. M.-2 P. M. Sectional Business Meetings.
Production, Room 8, Dairy Building.
Manufacturing, Room 110, Home Economics Building, East Campus.
Extension, Room 117, Dairy Building.
- 2 P. M.-4 P. M. Extension Section, Room 117, Dairy Building.
- 2 P. M.-4:30 P. M. Production Section, Room 8, Dairy Building.
- 2 P. M.-4:30 P. M. Manufacturing Section, Room 110, Home Economics Building, East Campus.
- 2 P. M.-4 P. M. Children and young folks program.
Swimming at the Glennland Pool, Pugh Street and Beaver Avenue. Exclusive use of pool reserved. Admission by complimentary ticket at registration.
- 2 P. M.-4 P. M. Entertainment for ladies at The Nittany Lion Inn, West Campus. Complimentary tickets at registration.

6:30 P. M. Subscription banquet, McAllister Hall. Tickets to be purchased at registration.

Friday, June 19

8 A. M.—9 A. M. General Business Session, College Auditorium, Central Campus.

9 A. M.—12:30 P. M. Production Section, Room 8, Dairy Building.

9 A. M.—12:30 P. M. Manufacturing Section, Room 110, Home Economics Building, East Campus.

12:30 P. M.—1:30 P. M. Lunch hour.

2 P. M. Optional tours—Transportation not furnished.

Kylertown pasture fertilizer experiment in cooperation with the U. S. Bureau of Plant Industry. Located 34 miles north of State College on Pa. Route 53.

Fisherman's Paradise, 6 miles northeast of State College.

U. S. Dairy Bureau, Washington, D. C. Members of the Bureau will entertain visitors at the Laboratories in Washington and at the farm at Beltsville, Md., on Saturday morning, June 20, at 9:00 o'clock.

SECTION PROGRAMS

EXTENSION SECTION

E. J. PERRY, *Chairman*

Tuesday afternoon, June 16

Dairy Building, Room 117

1:00—2:30—TESTING COMMITTEE REPORTS

FLOYD JOHNSTON, *Chairman*

(Papers limited to 10 minutes)

E1—Securing qualified cow testers for dairy herd improvement associations. C. R. Gearhart, Pennsylvania State College.

E2—Dairy herd improvement association supervisor's conferences. M. J. Regan, University of Missouri.

E3—Combining farm accounts with D. H. I. A. records. E. A. Gauntt, New Jersey College of Agriculture.

E4—The county agricultural agent's responsibility in connection with a testing program. G. E. Gordon, University of California.

E5—Handling herd improvement and advance registry testing in connection with herd improvement testing associations. Floyd Johnston, Iowa State College.

2:30-4:00—SIRE COMMITTEE REPORTS

J. F. KENDRICK, *Chairman*

- E6—Conducting a bull association program. S. J. Brownell, New York College of Agriculture.
- E7—The future dairy herd improvement association sire program. E. E. Heizer, Ohio College of Agriculture, and J. F. Kendrick, Bureau of Dairying, United States Department of Agriculture.
- E8—Dairy herd analysis and proved sire work. E. H. Loveland, Vermont College of Agriculture, and R. G. Connelly, Virginia College of Agriculture.

PRODUCTION SECTION

Wednesday afternoon, June 17, 1:00-4:00 o'clock

Dairy Building, Room 8

K. S. MORROW, *Chairman*

GENETICS, MASTITIS, NUTRITION

(Papers limited to 10 minutes)

- P1—Relative genetic worth of partial lactation records of various lengths. W. L. Gaines, University of Illinois.
- P2—Heritability of butterfat percentage and butterfat production in the data with which sires have been proved in Iowa. Jay L. Lush and Earl N. Shultz, Iowa State College.
- P3—Some results of eighteen years of close breeding with Jerseys. W. M. Regan, S. W. Mead and P. W. Gregory, University of California.
- P4—Evaluating inheritance for type from grades. W. W. Swett, Bureau of Dairy Industry, U. S. D. A.
- P5—Some additional findings of the dairy cattle germ plasm survey. M. H. Fohrman, Bureau of Dairy Industry, U. S. D. A.
- P6—A report on a control program for bovine infectious mastitis based on segregation of infected animals. E. O. Anderson and W. N. Plastridge, Connecticut Agricultural College, Storrs.
- P7—Studies on aseptically drawn milk from Bang's disease positive and Bang's disease negative cows. H. B. Morrison and F. E. Hull, University of Kentucky.
- P8—Two types of blindness in cattle and their possible relation to vitamin deficiency. A. H. Kuhlman, W. D. Gallup and E. Weaver, Oklahoma A. and M. College.
- P9—Production of white spotted kidneys in calves. L. A. Moore and E. T. Hallman, Michigan State College.
- P10—Tuberculosis in milk goats. O. C. Cunningham and L. H. Addington, New Mexico A. and M. College.
- P11—Vitamin A replaces whole milk in the calf ration. H. T. Converse and Edward B. Meigs, Bureau of Dairy Industry, U. S. D. A.

- P12—Supplementing a normal ration for dairy calves with cod liver oil. P. M. Reaves, Virginia Polytechnic Institute, and C. Y. Cannon, Iowa State College.
- P13—The physiological effect of a hegari fodder and cottonseed meal ration on dairy cows. O. C. Cunningham, L. H. Addington and E. M. Lantz, New Mexico State College.
- 4:00-4:30—Sectional Committee Meetings.

MANUFACTURING SECTION

Wednesday afternoon, June 17, 1:00-4:30 o'clock

Home Economics Building

L. M. THURSTON, *Chairman*

VITAMINS—CHEMISTRY—TECHNIQUES

(Papers limited to 10 minutes)

- M1—Results obtained when the several Minnesota reagents were employed for testing buttermilk. D. F. Breazeale and E. W. Bird, Iowa State College.
- M2—The effect of preservatives on the results obtained with ice cream mixes by several testing methods. P. H. Hostetler, C. A. Iverson and E. W. Bird, Iowa State College.
- M3—The determination of citric acid in milk. H. L. Templeton, University of Wisconsin.
- M4—Vitamin C content of milk. C. H. Whitnah and W. H. Riddell, Kansas Agricultural College.
- M5—Vitamin C content of dairy orange beverages. M. J. Mack, C. R. Fellers, W. A. MacLinn and D. A. Bean, Massachusetts State College.
- M6—Catalytic destruction of vitamins by manganese during the pasteurization process. A. D. Pratt, Virginia A. and M. College.
- M7—X-ray diffraction studies of cheese protein during the ripening of Cheddar cheese. S. L. Tuckey, H. A. Ruehe and G. L. Clark, University of Illinois.
- M8—The relation of the oxidation-reduction potential of milk to oxidized flavor. R. E. Webb and J. L. Hileman, Dairymen's League Laboratories.
- M9—Some observations on the electrokinetic potential of milk fat. E. L. Jack and C. D. Dahle, Pennsylvania State College.
- M10—A new type of quinhydrone electrode for directly determining the hydrogen-ion concentration of cheese and other materials. George P. Sanders and E. O. Whittier, Bureau of Dairy Industry, U. S. D. A.
- M11—An improved motor driven curd tester. L. A. Chambers, University of Pennsylvania, Philadelphia.

- M12—Use of a dynamic foam meter for measuring foaming ability of ice cream mixes. J. L. Minkin and J. H. Erb, Ohio State University.
4:00–4:30 Sectional Committee Meetings.

EXTENSION SECTION

Thursday morning, June 18

Dairy Building, Room 201

E. J. PERRY, *Chairman*

8:00–10:00 Extension Exhibits.

C. R. Gearhart, *Chairman*
C. J. Fawcett, Massachusetts
J. G. Hayes, Michigan
E. A. Hanson, Minnesota
R. T. Keithley, Virginia

Exhibits from several states showing Dairy Extension methods in teaching will be on display with explanatory labels during the entire meeting. The above committee and specialists will be present during this period to discuss and explain the exhibits from their own state.

PRODUCTION SECTION

Thursday morning, June 18, 9:00–12:00 o'clock

Dairy Building—Room 8

K. S. MORROW, *Chairman*

NUTRITION (Continued)—VITAMINS

(Papers limited to 10 minutes)

- P14—The vitamin A requirements of dairy cows for reproduction and lactation under practical conditions. E. B. Meigs and H. T. Converse, Bureau of Dairy Industry, U. S. D. A.
P15—Reproduction of dairy cows on a ration of prairie hay and cottonseed meal. A. H. Kuhlman, E. Weaver and A. Nalbandov, Oklahoma A. and M. College.
P16—The effect of sprouted oats on reproduction of dairy cattle. H. P. Davis and I. L. Hathaway, University of Nebraska.
P17—Magnesium carbonate and magnesium oxide supplements to a whole milk ration for dairy calves. C. F. Huffman and C. W. Duncan, Michigan State College.

- P18—Gross and microscopic pathology associated with low blood magnesium in dairy calves. L. A. Moore, L. B. Sholl and E. T. Hallman, Michigan State College.
- P19—Cod liver oil and muscle dystrophy in calves. G. Davis and L. A. Maynard, Cornell University.
- P20—Effect of phosphorus intake on the calcium and inorganic phosphorus content of whole blood of dairy heifers during the periods of gestation and first lactation. A. H. Van Landingham, H. O. Henderson and G. A. Bowling, University of West Virginia.
- P21—Relative utilization by dairy cows of calcium and phosphorus in dicapho (dicalcium phosphate) and bonemeal (tricalcium phosphate). J. A. Newlander, H. B. Ellenberger and C. H. Jones, University of Vermont.
- P22—Body analyses of dairy cows after long time calcium and phosphorus balance trials. H. B. Ellenberger, J. A. Newlander and C. H. Jones, University of Vermont.
- P23—The influence of roughage on the vitamin D potency of milk. G. C. Wallis and T. M. Olson, South Dakota State College.
- P24—A further study of the factor in soybeans affecting the vitamin A value of butter. S. M. Hauge, J. W. Wilbur and J. H. Hilton, Purdue University.
- P25—The rate of change in the vitamin A content of milk. W. C. Loy, J. H. Hilton, J. W. Wilbur and S. M. Hauge, Purdue University.

MANUFACTURING SECTION

Thursday morning, June 18, 9:00–12:00 o'clock

Home Economics Building

L. M. THURSTON, *Chairman*

MARKET MILK

(Papers limited to 10 minutes)

- M13—Milk inspection work in the United States. T. B. Harrison, University of Tennessee.
- M14—A study of the abnormal relationship of fat to solids-not-fat in milk. H. C. Moore and K. S. Morrow, University of New Hampshire.
- M15—Quality—composition relationships in goats milk. J. C. Marquardt, New York Agricultural Experiment Station, Geneva.
- M16—Observations on the development of rancidity in sweet milk, cream and butter. E. L. Fouts and E. Weaver, Oklahoma A. & M. College.
- M17—Concerning the cause of rancid and oxidized flavors of bovine origin. J. A. Anderson, Rutgers University, J. G. Hardenbergh and L. T. Wilson, Walker-Gordon Laboratory.
- M18—Study of the causes of bitter flavor in cream. L. J. Manus and L. M. Thurston, West Virginia University.

- M19—The activatability of milk with ultra-violet light. W. E. Krauss, R. M. Bethke and R. G. Washburn, Ohio Experiment Station, Wooster.
- M20—The effects of feeding ergosterol to cows on the activatability of the milk. R. F. Light, L. T. Wilson and C. N. Frey, Fleischmann Laboratories, New York, and Walker-Gordon Laboratory.
- M21—Treatment of milk previous to separation and the effect on viscosity of market cream. H. B. Henderson and H. B. Ellenberger, University of Vermont.
- M22—A study of the adaptability of the vacuum seal for milk bottles. W. H. Brown, P. H. Tracy and M. J. Prucha, University of Illinois.
- M23—Instant whipping of cream by aeration. G. A. Getz, G. F. Smith and P. H. Tracy, University of Illinois.
- M24—The influence of method of sterilizing equipment upon the development of oxidized flavor in milk. A. C. Dahlberg and D. C. Carpenter, New York Agricultural Experiment Station, Geneva.

EXTENSION SECTION

Thursday afternoon, June 18

Dairy Building, Room 117

E. J. PERRY, *Chairman*

1:00-2:00—SECTION BUSINESS MEETING

2:00-3:00—FEEDING COMMITTEE REPORTS

A. R. MERRILL, *Chairman*

(Papers limited to 10 minutes)

(These papers are presented with a view of applying the facts
to an Extension teaching program.)

- E9—Alfalfa-molasses silage *vs.* alfalfa hay as a roughage for lactating dairy cows. Russell E. Horwood, Michigan State College.
- E10—Calf starters fed dry with limited whole milk. E. S. Savage, New York College of Agriculture.
- E11—Sudan grass and sweet clover as temporary pasture crops. R. A. Acherman and H. O. Henderson, West Virginia College of Agriculture.
- E12—Summer decline in milk production. H. O. Wales, J. W. Linn and F. W. Atkeson, Kansas State College.
- E13—Feeding more roughage to dairy cows. C. F. Huffman, Michigan State College.

3:00-4:00—CALF CLUB COMMITTEE REPORTS

DWIGHT M. SEATH, *Chairman*

- E14—4-H Dairy Club work as a dairy extension project. J. Nageotte, Pennsylvania State College.

- E15—4-H Club junior bull rings. M. L. Flack, University of Nebraska.
 E16—Dairy projects for older boys. E. N. Shultz, Iowa State College.
 E17—The 4-H classification at the national dairy show. D. M. Seath, Kansas State College.

PRODUCTION SECTION

Thursday afternoon, June 18, 1:00-4:30 o'clock

Dairy Building, Room 8

K. S. MORROW, *Chairman*

MILK SECRETION, A. I. V. SILAGE, TECHNIQUES

(Papers limited to 10 minutes)

- 1:00-2:00—Sectional Business Meeting.
- P26—Site of synthesis of fat in the mammary gland. P. Kelly and W. E. Petersen, University of Minnesota.
- P27—Galactin content of pituitaries. R. P. Reece and C. W. Turner, University of Missouri.
- P28—Bovine ovarian reactions to various gonadotropic hormone preparations. L. E. Casida, University of Wisconsin.
- P29—Comparisons of arterial and mammary venous bloods as related to milk secretion. W. R. Graham, Jr., University of Missouri and National Institute for Research in Dairying, Reading, England.
- P30—Effect of hypophysectomy on development and function of the mammary gland. E. T. Gomez and C. W. Turner, University of Missouri.
- P31—The vitamin A Content of A. I. V., molasses and normal silage and the effect of feeding these silages upon the vitamin A content of milk. I. L. Hathaway, H. P. Davis and J. C. Brauer, University of Nebraska.
- P32—Studies on A. I. V. silage, Part I—Preparation and feeding. C. F. Monroe and C. C. Hayden, Ohio Agricultural Experiment Station, Wooster.
- P33—Studies on A. I. V. silage, Part II—Nutrient preservation and physiological effects on the cow. A. E. Perkins and C. F. Monroe, Ohio Agricultural Experiment Station, Wooster.
- P34—Studies on A. I. V. silage, Part III—Carotene preservation and biological properties of the milk. W. E. Krauss and R. C. Washburn, Ohio Agricultural Experiment Station, Wooster.
- P35—Photographic techniques as applied to the dairy industry. R. F. Morgan, University of Nebraska.
- P36—Alignment charts for estimating profit per cow and per unit milk. S. Brody and A. C. Ragsdale, University of Missouri.
- P37—A lesson in feeds. R. B. Becker, University of Florida.

MANUFACTURING SECTION

Thursday afternoon, June 18, 1 00-4 30 o'clock

Home Economics Building, Room 110—East Campus

L M THURSTON, *Chairman*

BACTERIOLOGY

(Papers limited to 10 minutes)

1 00-2 00—Section business meeting

M25—Modified medium and incubation temperatures as they affect bacteria counts of milk containing organisms arising from various sources of contamination A Bradfield and H B Ellenberger University of Vermont

M26—The present status of the proposal to change the composition of the agar and temperature of incubation of the standard agar plate technique of the American Public Health Association R S Breed, New York Experiment Station, Geneva

M27—*Streptococcus lactis* in raw and pasteurized milks of very high quality E S Yawger and J M Sherman, Cornell UniversityM28—The characteristics of freshly isolated cultures of *Lactobacillus bulgaricus* J M Sherman and H M Hodge, Cornell University

M29—The heat resistance of colon organisms in milk C N Stark and Mary C Patterson, Cornell University

M30—The significance of bacterial and chemical changes occurring in mastitis milk and their correlation with milk production L A Burkey, G P Sanders and J F Cane, Bureau of Dairy Industry, U S D A

M31—Frequency of the *Escherichia aerobacter* species in commercial butter E H Parfitt Purdue University

M32—A comparison of media used for determining the bacterial content of ice cream F J Babel and E H Parfitt Purdue University

M33—The effect of certain *Penicillia* on the volatile acidity and the flavor of Iowa blue cheese (Roquelort type) C B Lane, Iowa State College

M34—Sanitary aspects of homogenized milk M J Prucha and P H Tracy, University of Illinois

PRODUCTION SECTION

Friday morning, June 19, 9 00-12 30 o'clock

Dairy Building—Room 8

K S MORROW, *Chairman*

SILAGE—RATIONS—HAY

(Papers limited to 10 minutes)

P38—Production of dairy cows when fed only silage and cracked soybeans. N. K. Williams, C Y. Cannon and D L. Espe, Iowa State College.

- P39—Methods of making grass silage. T. E. Woodward, Bureau of Dairy Industry, U. S. D. A.
- P40—Sweet potatoes *versus* silage for milk production. R. H. Lush, Louisiana Agricultural Experiment Stations.
- P41—Soy bean hay as the sole roughage for dairy cows. L. F. Herrman and G. A. Bowling, West Virginia University.
- P42—Limited grain feeding of dairy cattle. C. E. Wylie and L. R. Neel, University of Tennessee.
- P43—The value of grinding grains for lactating dairy cattle. A. L. Darnell, Texas A. and M. College and O. C. Copeland, Texas Agricultural Experiment Station.
- P44—The feed value of oat mill feed as a hay substitute for dairy cows. A. W. Lathrop and G. Bohstedt, University of Wisconsin.
- P45—Milk and butterfat yields of Holstein cows on rations restricted to roughage. J. R. Dawson and R. R. Graves, Bureau of Dairy Industry, U. S. D. A.
- P46—Some results of eight years of investigation concerning the rôle of roughage in the diet of ruminants. S. W. Mead and H. Goss, University of California.
- P47—Spectrophotometric data bearing on the character of the pigments obtained in routine determinations of carotene in hays, silages and freshly cut plant materials. E. A. Kane, H. G. Wiseman, A. H. Hartman and C. A. Cary, Bureau of Dairy Industry, U. S. D. A.
- P48—Rate of decomposition of carotene in hays during storage at different seasons of the year. H. G. Wiseman, E. A. Kane and C. A. Cary, Bureau of Dairy Industry, U. S. D. A.
- P49—Effect of moisture content and density of stored roughage on temperatures attained during storage and the quality of the product. J. B. Shepherd, T. E. Woodward and R. R. Graves, Bureau of Dairy Industry, U. S. D. A.
- P50—The effect of certain factors upon the color and pigments of alfalfa hay in storage. T. E. Woodward, Bureau of Dairy Industry, U. S. D. A.

MANUFACTURING SECTION

Friday morning, June 19, 9:00–12:30 o'clock

Home Economics Building

L. M. THURSTON, *Chairman*

CHEESE—BUTTER—ICE CREAM

(Papers limited to 10 minutes)

- M35—Wrappers for processed cheese. H. L. Templeton, University of Wisconsin.
- M36—A study of inexpensive milk pasteurizing units for cheese factories. W. V. Price, University of Wisconsin.

- M37—Salting and cooking curds in the manufacture of several varieties of cheese. J. C. Marquardt, New York Agricultural Experiment Station, Geneva.
- M38—The influence of salt on the composition and quality of brick cheese. E. L. Byers and W. V. Price, University of Wisconsin.
- M39—The utilization of whey in the preparation of some new food products. B. H. Webb and G. A. Ramsdell, Bureau of Dairy Industry, U. S. D. A.
- M40—A pasteurizing difficulty experienced where whey cream is processed. L. C. Thomsen, University of Wisconsin.
- M41—A summary of results of experimental studies of certain factors affecting churning losses. H. A. Derby, D. F. Breazeale, and E. W. Bird, Iowa State College.
- M42—A preliminary report of the effect of certain neutralizers on the churning loss and the keeping quality of butter. N. E. Fabricus, D. F. Breazeale and E. W. Bird, Iowa State College.
- M43—Some factors influencing the spreadability of butter. S. T. Coulter and W. B. Combs, University of Minnesota.
- M44—A proposed score card for judging churning cream. L. H. Burgwald and J. H. Erb, Ohio State University.
- M45—A comparison of pressure and centrifugal homogenization of ice cream mixes. J. C. Henning, New York Agricultural Experiment Station, Geneva.
- M46—The use of sodium alginate as a stabilizer in ice cream. P. H. Tracy, G. L. Gibson and S. L. Tuekey, University of Illinois.
- M47—Recent studies on the use of dextrose in ice cream. W. J. Corbett and P. H. Tracy, University of Illinois.

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ABSTRACTS OF PAPERS PRESENTED AT ANNUAL MEETING*

GENERAL SESSION

Science and Practical Dairying. W. J. FRAZER, University of Illinois.

Uncle Sam keeps three immense dairy herds of 8,000,000 cows each. Since the average production of all these 24,000,000 cows is only 161 pounds of fat a year, this means, according to the spread in production of cows tested, that the upper third averages 220 pounds, the middle third 157 pounds, and the lowest third 106 pounds. Into the board and keep of the poorest two of these three huge herds goes the productive power of a larger area of good land than is covered by the states of Illinois and Iowa combined, as well as the money and energy of more than a million dairy farmers and their families.

Such facts as these should challenge every man connected with the dairy industry. The reasons for these conditions, as expressed by several of our best informed and most thoughtful dairymen, are that 90 per cent of the cows are so poorly and uneconomically fed and cared for that they are decidedly hindered at some time during the year in making their most profitable production. Two-thirds of the cows are not capable of producing 300 pounds of fat even if well fed and cared for. Ninety per cent of the dairy bulls now in use are not capable of siring 350-pound daughters if mated with dams of that capacity. Seventy-five per cent of the heifers are so poorly fed and cared for at some time during their raising that their efficiency as dairy cows is reduced.

What has the Dairy Science Association to do with preventing such an appalling waste of natural and human resources? The extension men and college teachers of dairy production are the connecting link between the fine research now being conducted and the dairy farmer. Unless these men keep in touch with scientific developments and then in some way get them into actual practice on the majority of our dairy farms, the balance-wheel of our whole Dairy Science Association is off center. Our extension men have already gotten the cows in our Dairy Herd Improvement Association herds up to an average of 317 pounds of fat a year, which is almost twice the average of the cows in the United States. Yet only about 2 per cent of Uncle Sam's 24,000,000 milk cows are in Dairy Herd Improvement Associations. What

* Authors have not corrected the proofs.

can the Dairy Science Association do to increase the production and profit from the other 98 per cent?

The National Survey of Sediment Testing of Cream and Butter. G. F. STEWART AND M. E. PARKER, Research Committee, American Association Creamery Butter Manufacturers.

This survey presents the preliminary results of a national investigation involving over 1,000 trials by creamery and agricultural college laboratories. The data have been collected and compiled according to the following state groups: (1) New York, Ohio; (2) Indiana, Illinois, Iowa; (3) Missouri, Kansas, Nebraska; (4) Michigan, Minnesota, North Dakota; (5) Kentucky, Tennessee; (6) Texas, and (7) California, Oregon. The data also are presented to show seasonal influences for Fall, Winter, and Spring months through May, 1936.

This national survey of methods determining sediment incream and butter indicates that—

- (1) The milk sediment testing equipment can be used with satisfactory results, and that
- (2) The Connecticut Official Milk Sediment Standards of 1931 can be used for interpreting results.

Of the eight different methods studied, at least two different methods for determining sediment in cream and in butter have been found to be satisfactory.

Notice: MEN Wanted! W. V. DENNIS, Pennsylvania State College.

This might be a sign of the revival of industry; right here it is a summons to very earnest thinking. One of the most tragic aspects of our restless present is our lack of faith in our leaders, industrial, financial, political, educational and religious. In the United States there are eight million youth, 18 to 25 years of age, out of work, three million of whom have never had a job. Even with this huge army to choose from the cry is going up on all sides, "We want *men*."

In industry, banking, trade and the professions employers are seeking *men*. Individuals with ample technical training and ability are plentiful; MEN are alarmingly scarce. The emphasis in selecting new salaried employees today is not so much on technical skill as upon personality, character, integrity, the will to accept and the capacity to carry responsibility.

This is a demand made alike of colleges and business institutions that reliable men be developed in the educational and administrative processes. This involves for many of us a new conception of our responsibility for the younger men who come under our influence. Modern ways of living, the character of the present day home, the tempo of life today and its prevailing poverty in spiritual dynamic make increasingly difficult the development of

the sort of men needed for these hours of crisis, these times of great economic and social changes.

The challenge of this demand for men is first to us who occupy in educational and business fields positions of leadership as administrators, counselors, experts in technique and as intellectual exciters. Is our equipment adequate for the task before us? What are our attitudes, and are they equal to the strain and stress involved in the inevitable adjustments? What is the nature of the human material with which we must work, and what of our methods of dealing with this material? Just what are our objectives? How far ahead are we seeing?

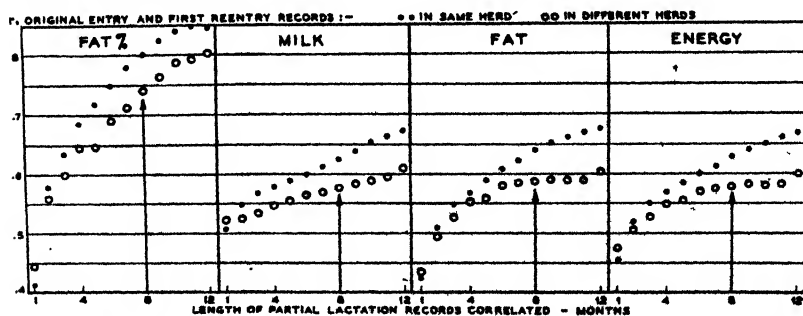
The future of the dairy industry, on the farm, in the manufacturing plant, and in the marketing mechanisms depends upon our ability and upon our willingness to meet the greatest need of our times, the developing of *men*. Upon us and upon men like us very largely depends the fate of western civilization. Notice: MEN Wanted! Can we furnish them? If so, How?

PRODUCTION SECTION

P1. Relative Genetic Worth of Partial Lactation Records of Various Lengths. W. L. GAINES, University of Illinois.

At the Cornell meeting in 1934 an energy-size index was proposed. It seems desirable to modify the terms of the index to "Calories of milk energy per kilogram initial live weight of cow per day for the first eight monthly tests of each lactation" (designated Cals./Kgs./Ds. or C-K-D, Proceedings American Society of Animal Production, 1935). C-K-D is a purely factual expression, in contrast to the fictitious nature of corrected records. It is a dynamic or metabolic measure of lactation, directly comparable between dairy cows of all breeds, and suited to biological analysis. In genetic analysis three mutually independent values are used: 1, live weight of cow or size of machine; 2, C-K-D or working efficiency of machine; 3, fat percentage or kind of work of machine. *Correction factors are avoided.*

It is the purpose of this paper to examine one point in the above plan, namely, the genetic worth of the 8-month record as compared to other lengths of partial lactation, where pregnancy is not a complicating factor. (The 8-month idea is not new, being used by Gowen as early as 1920, Genetics, and there is also the still earlier 8-months-after-calving 7-day Holstein system.) Material is drawn from the calendar-month original-entry and first-reentry records of Guernsey cows carrying a calf less than 5 months during the 365-day partial lactation. The correlations between the 2 records of the same cow are computed for the first full calendar month, the first 2 full calendar months, and so on to the first 11 full calendar months, and finally for the official 365-day record which usually embraces a partial month at start and finish. The coefficients (r) for 939 cows making both records in the same herd, and 237 cows making the 2 records in different herds are presented graphically.



Conclusion and Opinion. The r curve for fat percentage rises more rapidly with length of record than does the r curve for milk. This may be

linked with the number of tests rather than length of record as such, since the fat percentages are based on 1-day or 2-day samples each month, while the milk yields are based on scale weights of each milking. Where milk weights as well as fat percentages are based on 1-day monthly determinations, as in present common practice, the *r* curve for fat in the graph may be taken to represent the relative genetic worth of various lengths of record for farrow cows with respect to amount of yield. Whether the *r* curve for records in the same herd or the *r* curve for records in different herds is more representative is an involved question. The significance of differences in the *r* curves for milk, fat and energy is also an involved question.

Production should be recorded continuously as in the Herd Test plan. From the continuous records the first 8 monthly tests of each lactation may be used for genetic analysis. In the sire progeny chart as presented, the last three columns illustrate the data to be used for comparisons, either intra-breed or interbreed.

SIRE A																
OWNER OF DAUGHTER	DAUGHTER AND DATE OF BIRTH	CALVING INTERVAL RECORD						FIRST 8 MONTHS (67 YEAR) RECORD								
		CALVED DATE	AGE YRS	CALVING INTERVAL YRS	IN MILK YRS	DRY YRS	MILK LBS	FAT LBS	INITIAL CONDITION SCALE 1-5	TOTAL FEED PER DAY SCALE 1-9	ENVIRONMENT NO. SCALE 1-9	INITIAL LIVE WEIGHT LBS	ENERGY-SIZE INDEX C-K-D	FAT PERCENTAGE %		
A	A 32 000	33 907	1 91	1 07	66	21	5018	275	5	7	2 17	8	745	211	5 38	
A	A 32 000	34 978	2 98	1 30	1 15	.15	9360	341	5	8	3 00	8	916	230	5.50	
A	A 32 419	34 928	2 31	.86	.80	08	8056	366	5	7	2 33	7	800	276	6 07	
A	A 32 419	35 806	3 39						5	6	3 00	8	896	245	5 96	
26 DAUGHTERS AVERAGE												812	251	5 61		

P2. Heritability of Butterfat Percentage and Butterfat Production in the Data With Which Sires Have Been Proved in Iowa. JAY L. LUSH AND EARL N. SHULTZ, Iowa State College.

The first 355 dairy sires proved in Iowa had 2,385 daughters to be compared with dams. These data were studied, largely by correlations between daughter and dam within sire, to find how highly hereditary were butterfat percentage and total fat production. About one-half of the variance in percentage could be construed as hereditary in the simple additive manner. The corresponding fraction for total fat production was about one-fourth. The first 225 sires were proved with C. T. A. yearly records and the later ones were proved with lactation records. The C. T. A. yearly records showed the hereditary differences between the cows a little more clearly than the lactation records but the difference between the two kinds of records was far below the level of statistical significance. About one-sixth of the variance in test and about one-third of that in total fat production were caused by management or environment which were alike for all the cows in each herd but differed from herd to herd. Tentatively less than ten per cent of the variance in lactation length seems to be hereditary in the simple additive sense and only one-seventh of it seems attributable to general herd management or environment. From these findings the comparative accuracy of several kinds of progeny tests of sires is expressed both in pounds and in

terms of correlation, for future use again in the same herd or for future use in other herds chosen at random.

Forty-three per cent of all sires were proved with only five pairs of daughters and dams. Two-thirds were proved on six or less and only 9 per cent had more than ten pairs. As in most such studies, there was considerable regression from the dams toward the average level of the breed so that a majority of the daughters out of cows producing less than 400 pounds were better than their dams but as the dams' production rose above 400 pounds the percentage of daughters which were better than those dams decreased rapidly.

P3. Some Results of Eighteen Years of Close Breeding With Jerseys.

W. M. REGAN, S. W. MEAD, AND P. W. GREGORY, University of California.

In the spring of 1918, the purebred Jersey herd of the New Jersey Experiment Station, consisting of 3 bulls and 22 females, was entered on an experiment which had for its object the fixing of production through inbreeding and selection. Four years later these animals were combined with 29 Jerseys owned by the California Experiment Station at Davis. Since that time, no outside blood has been added. Sire to daughter matings are practiced. When necessary to replace a bull, his most highly inbred son, out of a cow possessing desirable type and production, was selected to take his place. The productive capacity of all females was determined in our own herd, while the transmitting ability of male offspring for both production and defects was determined in the herds of cooperating dairymen.

The following table gives the important facts concerning the transmitting ability of the original herd sires, as shown by the recent germ plasm survey made by the Bureau of Dairying. All daughters were tested; records were for 10 months, starting at 2 years of age.

	PAIRS	FAT PRODUCTION		CLASSIFICATION		
		Daughters	Dams	% fat	Lbs milk	Lbs fat
Pogis Torono Experiment	26	411	403	Fair	Good	Fair
Rutgers Fern Napoleon	19	453	426	Fair	Fair	Good
Rinda Lad St. Mawes						
Lad	8	504	466	Good	Fair	Good
Octavias Rinda Lad	11	487	363	Excellent	Excellent	Excellent

Ten sons of these bulls have been proven in the herds of the cooperators. The results of 197 dam and daughter comparisons show an average increase, for the daughters, of 46 pounds of fat. The daughters of every bull have averaged better than their dams. The range of increase was from 21 to 103 pounds.

While production records have been obtained on some inbred animals carrying 75 per cent, and a few as much as 87.5 per cent of the blood of their sire, the number of such individuals is so small that reliable conclusions cannot be drawn. It can be definitely stated, however, that there has been no loss in body size or breeding efficiency.

The following simple recessive hereditary defects have appeared in the inbred stock: hairless, congenital blindness, and a form of acrodysplasia. A program designed to purge the herd of these defects is in operation.

P4. Evaluating Inheritance for Type from Grades Recorded in the Germ Plasm Survey. W. W. SWETT, Bureau of Dairy Industry, U. S. D. A.

Type grades for individual cows were recorded in approximately 400 of the reports of dairy herds submitted for analysis in connection with the Survey for Superior Germ Plasm recently conducted by the United States Department of Agriculture. The inheritance of individual sires was evaluated by assigning numerical ratings of 4, 3, 2, and 1 respectively to grades of Excellent, Good, Fair, and Poor, and comparing the average ratings of the daughters of the sire with that of their dams. The increase or decrease effected by each sire was expressed as a percentage of the maximum possible change, which is 3 points (4 to 1 or 1 to 4).

The evaluation of progress in establishing superior germ plasm for type in a herd involved the consideration of several factors such as (a) the proportion of the proved sires used that raised type-level, (b) the amount of improvement they effected, (c) the sequence of the superior and inferior sires evaluated, (d) the number of unproved sires, and (e) the extent to which female lines involved consecutive crosses to proved sires. Only herds having 2 or more proved sires (sires with at least 5 dam-daughter comparisons for type) were included in the herd-progress evaluation. Seventy-seven of the 228 herds meeting this requirement were listed as having shown some indications of progress in establishing superior germ plasm for type.

P5. Some Additional Findings of the Dairy Cattle Germ Plasm Survey. M. H. FOHRMAN, Bureau of Dairy Industry, U. S. D. A.

The discussion of the results of the germ plasm survey as given in the 1936 Yearbook of Agriculture includes a statement that the time limitation for the preparation of this material made it impossible to include data on all herds received after December 1, 1935. However, a considerable volume of material came in after that date. This was examined on arrival and those herds which showed evidence of some progress were passed along for analysis; while the balance were laid aside for later consideration. Some of the herds received earlier which showed only one proved sire were also held out of the original analysis.

This action which was made necessary by the time restriction may have slightly warped the results, particularly the analysis made of the relative numbers of sires in the various classes, and for this reason the herds which were laid aside were later studied in order to have a more complete picture of the entire field covered by the survey. An additional reason for completing the analysis of these herds was to afford their owners the benefit resulting from the assay of their herds.

This paper presents the results of the study of this group of herds and any effects which it might have on the reported findings already published in the Yearbook.

P6. A Report on a Control Program for Bovine Infectious Mastitis Based on Segregation of Infected Animals. E. O. ANDERSON AND W. N. PLASTRIDGE, Connecticut Agricultural College.

Observations on the incidence of streptococcal mastitis in seven experimental herds over periods of from one to five years are described. Data collected before and after the adoption of a program of segregation based on periodic examinations (chiefly bacteriological) and segregation of animals shedding streptococci identified as *Streptococcus agalactiae*, are presented.

The results obtained indicate that:

1. The annual rate of spread of infectious streptococcal mastitis in infected herds may be reduced 50 to 100 per cent by the use of the segregation plan described.
2. While the rate of spread of infection is materially reduced by segregating infected animals at one end of the milking string and milking them last, complete separation of infected animals is necessary to entirely prevent the spread of infection.
3. Herds free from *Streptococcus agalactiae* may be established by segregation of the normal animals; disposal of infected individuals, and replacement by first calf heifers that have not been exposed to infection following parturition.

The results obtained on a herd recruited from pregnant heifers are of particular interest, as tests made at monthly intervals since the herd was started in 1932 show that the animals have remained free from *Streptococcus agalactiae* up to and including the last test which was made April 6, 1936.

P7. Studies on Aseptically Drawn Milk from Bang's Disease Positive and Bang's Disease Negative Cows. H. B. MORRISON AND F. E. HULL, University of Kentucky.

During the past year a study on milk drawn aseptically from Bang's disease negative and Bang's disease positive cows has been carried on in two

commercial dairies in Kentucky. Samples were secured from each quarter of 184 cows, making in all a total of 711 samples.

Both of these herds contained both Bang's disease positive and Bang's disease negative cows. On one farm the positive and the negative cows were housed in separate barns and kept in separate pastures so they had absolutely no contact with each other. On the other farm two separate herds were maintained in one of which the positive and negative cows were not separated either in the pasture or in the barn, and in the other herd the positive cows were kept in a separate pasture but stabled at one end of the barn. They entered the barn through a separate door and had no contact with the negative cows although they were milked and fed by the same men that cared for the negative cows.

Four examinations were made on the milk aseptically drawn from these cows as follows: Brom Thymol Blue reaction; Leucocyte content; Agglutination test; and the examination for the presence of streptococci.

SUMMARY

1. A comparison of all four tests on the same sample showed the largest group among the positive cows to be positive to all four tests and the largest group from the negative cows to be negative to all four tests.

2. It appears from these results that cows positive to Bang's disease are subject to considerably more udder trouble than cows negative to Bang's disease.

3. The results secured from these herds indicate that proper care and management of herds containing Bang's disease positive and negative cows may influence the amount of udder trouble to a considerable extent.

P8. Two Types of Blindness in Cattle and Their Possible Relation to Vitamin Deficiency. A. H. KUHLMAN, W. D. GALLUP, AND EARL WEAVER, Oklahoma A. & M. College.

Two types of blindness have been observed in calves fed beet pulp, cottonseed meal, and bone meal. Calves receiving this ration are kept in a well-lighted barn and are usually fed whole milk for 45-60 days and then skim-milk to the age of six months. Beet pulp and cottonseed meal, fed in the ratio of one pound of pulp to 0.74 pound of cottonseed meal, were offered as soon as the calves would eat these feeds. Bone meal was fed at the rate of 10 and 20 grams daily per calf. As soon as low blood Ca or P values were obtained for any calf, it was exposed to direct sunlight or received aerated cod liver oil or viosterol or both sunlight and one of the vitamin D supplements.

The suitability of this ration for studies involving vitamins A and D is shown by the fact that when it is supplemented with 30 cc. of cod liver oil daily, calves have exceeded the normal rate of growth by 10 to 40 per cent

between the ages of six and twelve months. None of these calves has ever shown any indications of blindness or any other eye trouble.

One type of blindness which appears to be temporary usually occurs while the animal is losing weight. It has been cured by the administration of such vitamin A supplements as canned tomatoes, cod liver oil, and caratone. This condition is probably typical vitamin A ophthalmia. It is associated with loss of appetite, bulging and watering of the eyes, grayish discoloration of the eyeball, ulceration of the eye, inflammation of the white portion of the eyeball, running at the nose, a rough, harsh coat, arched back, swollen joints, and convulsions. These symptoms usually appear when the calves are from 90 to 210 days of age.

The other type of blindness, which is permanent, apparently may occur simultaneously with the first, or may appear later or even when the animal is gaining in weight. In several cases it has also occurred independently, *i.e.*, in calves which have never shown vitamin A ophthalmia. This condition is less apparent by gross observation since the eyes appear to be normal and are not inflamed or discolored. The pupil, however, is always dilated. Blood analyses failed to show a deficiency of either Ca or P. One case developed even when the calf received 30 cc. aerated cod liver oil daily, indicating that vitamin D may not be involved.

Daily doses of 18,600 International units of vitamin A in canned tomatoes, 18,600 to 37,200 units of vitamin A supplied in caratone, (a crude extract of carotene), and 11,211 to 12,600 units of A supplied in cod liver oil, even when fed over long periods have not cured this type of blindness. The addition of 2,800 to 10,800 units of vitamin D in cod liver oil or viosterol in addition to sunlight also has not effected improvement in restoring sight. This investigation is being continued to determine whether or not this condition is due to constriction of the optic nerve.

It is interesting to note that of eighty-two calves from cows fed a ration of prairie hay and cottonseed meal, only one calf has been blind at birth. The eyes of this calf resembled the condition due to vitamin A deficiency, but became normal during the first week while nursing its dam. Thirty-nine heifers and ten bull calves have been raised on the basal ration of prairie hay and cottonseed meal and in no case has any calf ever developed blindness or other eye trouble. Apparently prairie hay contains the factor or factors which protect cattle against these two types of blindness.

P9. Production of White Spotted Kidneys in Calves. L. A. MOORE AND E. T. HALLMAN, Michigan State College.

When calves at 30 days of age are placed on a ration of skim milk, corn starch, bran, yeast, mineral or similar rations which are low in their vitamin A content, so-called white spotted kidneys develop in many of the calves. During the past four years some 30 cases have been noted of autopsy.

Macroscopically and microscopically the lesions are similar to those previously described which develop when colostrum is withheld from the new-born calf. The condition is also associated with the development of pneumonia and scours.

The calves usually come to autopsy at from 90 to 150 days of age. The feeding of carotene in the form of "caritol" seems to possess some preventative properties which would indicate that the condition may be related to vitamin A deficiency. Experiments are now in progress to establish the deficiency.

P10. Tuberculosis in Milk Goats. O. C. CUNNINGHAM AND L. H. ADDINGTON, New Mexico A. and M. College.

Since 1906 only five cows in the college dairy herd have reacted to the annual test for tuberculosis. Two of these reacted in 1929 and three in 1930. Post mortem revealed no visible tubercular lesions except in two cases of possible skin lesions.

Since 1919 the New Mexico Experiment Station has maintained a herd of milk goats for experimental breeding purposes. During the last decade the herd has usually contained about seventy individuals above six months of age. Since there is a wide-spread impression that goats are either immune or practically immune to tuberculosis and the presence of tuberculosis among animals is not general in the state, the goats were not tested for tuberculosis until 1931.

Two goats were removed from the herd as a result of the first tuberculin test. Both of these on post mortem showed pronounced tubercular lesions. Since 1931 five more goats have been removed from the herd as a result of applying the intradermal tuberculin test. One of these on post mortem showed pronounced tubercular lesions and three others minor lesions that may have been tubercular.

The authors feel that it is highly desirable that goats kept for the production of milk for human consumption be tested for tuberculosis the same as dairy cattle.

P11. Vitamin A Replaces Whole Milk in the Calf Ration. H. T. CONVERSE AND EDWARD B. MEIGS, U. S. Bureau of Dairy Industry.

In a paper read before this society in 1934 we concluded "that the whole milk in the calf ration is needed more for its vitamin A than for its fat or energy." The conclusion was based on the nearly normal six months' gains of a few calves getting only grain, hay, skim milk and a vitamin A supplement (cod liver oil or carotene) after three days on colostrum. The present paper gives additional evidence that it is not only safe to feed such a ration but that the gains in weight may be normal at thirty days as well as at older ages.

Our milk feeding schedule had been as follows: mother's milk for three days, Holstein whole milk to twenty days, a gradual change to all skim milk by thirty days, and the skim milk continued to six months. When the milk schedule was changed to all skim milk on the fourth day, the same amounts of skim milk, with its lower nutritive energy, were fed as of whole milk thus allowing much less energy during the first month.

Twenty calves, fed according to this skim milk schedule, have appeared quite normal and made about normal gains by six months although a few have made rather small gains and seemed somewhat undernourished during the first month. At twelve months of age, six heifers have made, on the average, almost exactly the expected gains in body weight.

Our skim milk schedule of feeding is now revised by increasing the amounts of it fed so that the calves get only slightly less nutrients from milk during the first month and slightly more during the second month than the old whole milk-skim milk schedule allowed. Five Holstein calves have been fed according to this increased schedule. With these calves, even the first month's average gain is greater than with those calves getting whole milk for the first twenty days.

P12. Supplementing a Normal Ration for Dairy Calves with Cod Liver Oil. P. M. REAVES, Virginia Polytechnic Institute, AND C. Y. CANNON, Iowa State College.

To study the effect of supplementing a normal ration for dairy calves with cod liver oil, two groups of four calves were used. The calves ranged in age from five days to sixty-four days, at the beginning of the trial. They were fed normally over a period of 139 days. At first whole milk was fed and later reconstructed skim milk. A concentrate mixture of corn, 4 parts; oats, 4 parts; linseed oil meal, 1 part; and wheat bran, 1 part, was fed, with good quality hay. The trial extended from January to May. The calves were in an open lot a part of the day when weather would permit. Both groups were handled and fed in the same manner, with the exception that the calves in the cod liver oil group received 20 cc cod liver oil daily until they reached a weight of approximately 200 pounds, at which time the oil was increased to 30 cc daily.

The results were measured by weekly weights and heights at withers. The blood of the calves was analyzed for calcium and inorganic phosphorus; the results of both groups were within the normal range. The calcium concentration was approximately the same for the two groups, while that of phosphorus was slightly higher for the cod liver oil group. The weight and height of all calves were equal to or above the Iowa normal (Ia. Bul. 154). The groups were very close in this respect.

The results of this trial indicate that the addition of cod liver oil to a normal ration did not benefit dairy calves.

P13. The Physiological Effect of a Hegari Fodder and Cottonseed Meal Ration on Dairy Cows. (Preliminary report.) O. C. CUNNINGHAM, L. H. ADDINGTON, AND EDITH M. LANTZ, New Mexico College of Agriculture and Mechanic Arts.

Twenty-one cows at the New Mexico Experiment Station were placed on a ration consisting of all the ground whole hegari plant they would consume—approximately 2½ pounds per 100 pounds of live weight—and enough cottonseed meal to supply the additional protein requirements of the individual cows. Each cow was placed on the ration immediately after she had freshened. The milk production as compared with that during previous lactations when the cows received the regular herd ration was about 8 or 10 per cent less than the expected, after correcting for age.

One group of cows has received no supplementary feed. One group received finely ground limestone (85% CaCO_3) at the rate of 2 per cent of the cottonseed meal. One group received Haliver oil as a supplement during their dry period, after completing the full lactation, and another group received Haliver oil following freshening at the beginning of their second lactation period. The twenty-one cows had produced thirty-five calves, all but two of which were apparently normal, before going on the experiment. Of the twenty-two calves born to these cows after being on the experimental ration and before any supplement was added, four have been classified as normal, four as weak, six as showing blindness or muscular incoördination, three as dying shortly after birth, two as dead at birth, and three abortions. Three of the cows that produced calves that were blind or calves showing muscular incoördination died shortly after the birth of their calves. Of three cows that received Haliver oil during their dry period, two produced normal calves and one a calf born during the night and found dead early in the morning under conditions that make the cause of death doubtful. Of the seven calves born of cows that received ground limestone, four have been classified as normal, one as weak, and two died shortly after birth.

Comparative feedings to rats (a) of butterfat from cows receiving the hegari and cottonseed meal ration and butterfat from those that received the regular herd ration, (b) of livers from calves whose dams received the hegari and cottonseed meal ration and from calves whose dams received the regular herd ration and (c) of livers from the cows themselves, all indicated a much lower vitamin A content of the substances from the cows receiving the experimental ration. A group of rats (one male, two females) placed on the experimental ration of hegari and cottonseed meal at weaning have produced no young up to nine and one-half months of age. A group receiving the experimental ration plus calcium carbonate has produced three litters containing nineteen young, and another group receiving the experimental ration plus Haliver oil has produced five litters containing thirty-one young.

Apparently the ration of cottonseed meal and the whole hegari plant is short in both vitamin A and calcium, and possibly other substances.

P14. The Vitamin A Requirements of Dairy Cows for Reproduction and Lactation Under Practical Conditions. EDWARD B. MEIGS AND H. T. CONVERSE, U. S. Bureau of Dairy Industry.

Groups of dairy cows, which were giving liberal quantities of milk and were free from infection with *Brucella abortus*, were fed for periods of several years on rations of grain combined with different kinds of hay. The average carotene contents of the various rations were determined approximately, and records were kept of the reproductive performance of the cows. On the rations containing the smaller quantities of carotene, there was a larger proportion of premature births, of still births, and of weak and blind calves. In the following summary, a calving is counted as normal if the calf was carried more than 269 days, was not blind at birth, and survived for 7 days or more.

On ration *I*, consisting of grain and U. S. No. 1 alfalfa hay, the average carotene content was approximately 26 parts per million, and the percentage of normal births, 91; Ration *V*, grain and U. S. No. 1 timothy hay; carotene, 8; normal births, 29 per cent; Ration *VII*, grain and No. 1 clover hay, light timothy mixed; carotene, 8; normal birth, 44 per cent; Ration *VIII*, grain and No. 3 alfalfa hay; carotene, 3; normal births, none; Ration *IX*, grain and No. 3 timothy hay; carotene, 3; normal births, none. The total number of calvings on each of the various rations varied from 6 to 22.

In other experiments it was found that the reproductive performance of cows on Ration *IX* could be greatly improved by supplementing it with such sources of vitamin A as carrots or cod liver oil, and that the reproductive performance of cows on Ration *V* was satisfactory if the cows were on this ration for not more than 6 months after a preceding period on pasture containing large amounts of carotene. Reproduction on Rations *VIII* and *IX*, however, was very unsatisfactory even after only five and a half months following a period on good pasture.

P15. Reproduction of Dairy Cows on a Ration of Prairie Hay and Cottonseed Meal. A. H. KUHLMAN, EARL WEAVER, AND ANDREW NALBANDOV, Oklahoma A. & M. College.

During the past few years considerable attention has been given to the importance of roughages of good quality in relation to reproduction in cattle. Results obtained in a study of the limitations of cottonseed meal in rations for dairy cattle over a nine-year period have consistently shown the value of Oklahoma prairie hay in protecting cattle against cottonseed meal injury. The breeding history of these cattle also shows that a ration of prairie hay and cottonseed meal fed to animals which have been kept in dry lot continuously has not impaired reproduction.

To date forty-seven different animals, all grade Jerseys, have been used in this study. Thirty-nine of these were started as day-old calves and eight were purchased when approximately a year old. The calves received whole milk for six weeks and then skimmilk until they reached the age of six months. Cottonseed meal and prairie hay were offered as soon as the calves showed a desire for these feeds. Excepting when cows were being "dried up," all animals have been fed approximately as much as each of these two feeds as they would consume. The animals have always been confined in dry lots. The eight heifers purchased as yearlings were fed and handled in the same manner as the other animals of the same age.

The results further confirm the earlier indications that on this restricted ration of only two feeds, cottonseed meal and prairie hay, no significant evidence of impairment of appetite or other physiological disturbances has ever become apparent during the periods of most rapid growth and development, and, further, that animals may be maintained satisfactorily for long periods of time on this ration. Thus far the available evidence continues to show that prairie hay when fed with cottonseed meal in the amounts indicated will protect cattle against so-called "cottonseed meal injury."

The results further indicate that the prairie hay used in this study, most of which was of average quality and for several years quite lacking in green color, supplied sufficient vitamin A or other factors necessary for normal development and reproduction.

P16. The Effect of Sprouted Oats on Reproduction of Dairy Cattle.

H. P. DAVIS AND I. L. HATHAWAY, University of Nebraska.

Considerable difficulty is often experienced by dairymen in getting virgin heifers as well as older cows to conceive. This condition is rather wide-spread, and it has been suggested that it may be due to a lack of vitamin E, although it seems that most dairy rations would have a fairly abundant supply of that vitamin. Winters and also Graves and Miller reported favorable results in feeding sprouted oats to cows that did not readily conceive. In 1931 tests were begun to determine the effect of feeding sprouted oats upon delayed pregnancy in dairy cattle. Two lots of ten virgin heifers were selected. Each lot was composed of one Guernsey, five Jersey, and four Holstein heifers balanced as nearly as possible with respect to age and relationship. As far as possible, the comparable animals of each lot were bred to the same bulls. Both lots were fed alfalfa hay *ad libitum* while in addition one lot received four pounds of sprouted oats per head daily. In the sprouted oats lot, six heifers became pregnant at one service, two required three services, one required four services and one required five services. In the check lot six conceived at one service, one at six services. The tenth animal had to be disposed of after three services, but was not pregnant at that time.

Twenty-one services or 2.1 services per pregnancy were required for the sprouted oats group of ten animals. Twenty-one or 2.3 services per pregnancy were required for the no oats group of nine animals.

In 1932 a second trial was started. Two lots of virgin heifers were again selected. Each lot was fed alfalfa hay and silage. One lot received four pounds of sprouted oats per head. This amounted to about two pounds of unsprouted oats. The check lot received two pounds daily per head of dry whole oats. There were twelve heifers representing three breeds in the sprouted oats group, and ten heifers representing four breeds in the dry oats lot. In the sprouted oats lot, four conceived at the first service, two after two services, three after three services, two after four services, and one conceived following seven services. In the dry oats lot, five conceived at one service, two after two services, one after three services, one after six services, and one after eight services.

Thirty-two services or 2.6 services per pregnancy were required in the sprouted oats lot. Twenty-six services or 2.3 services per pregnancy were required in the dry oats lot.

The experiment was repeated in 1934. Both lots were fed alfalfa hay *ad libitum*. In addition, one lot was fed four pounds of sprouted oats daily and the other lot was fed daily four pounds of dry whole oats per head. The lots were balanced as previously, with four breeds represented. There were eleven heifers in the sprouted oats lot and eleven heifers in the dry oats lot. In the sprouted oats group, one animal conceived at the first service; two after two services; five after three services; two after five services, and one conceived after seven services. In the dry oats lot, three conceived after one service; one after two services; three after four services; three after five services; and one after eight services.

Thirty-seven services or 3.3 services per pregnancy were required in the sprouted oats lot. Forty services or 3.6 services per pregnancy were required for the dry oats lot.

For a period of about five years, 1926 to 1931, about six pounds of sprouted oats were fed to each cow and bull daily. While it is hard to draw any definite conclusions from such mass feeding where there were no check groups, an examination of the number of services required for conception for each cow during that period was substantially the same as the average for periods before and after.

It would seem, therefore, upon the basis of our experience that sprouted oats had no marked effect upon the reproductive functions of either heifers, cows or bulls as measured by the services required for conception.

P17. Magnesium Carbonate and Magnesium Oxide Supplements to a Whole Milk Ration for Dairy Calves. C. F. HUFFMAN AND C. W. DUNCAN, Michigan State College.

Several investigators have shown that calves fed a whole milk ration manifest tetany. We observed that the addition of cod liver oil or viosterol in sufficient amounts to maintain normal plasma calcium and inorganic phosphorus values failed to prevent the onset of tetany associated with subnormal plasma magnesium.

Twelve calves were used in the phase of the investigation reported in this paper. The basal ration consisted of whole milk, corn starch or rice crispies, viosterol, iron, copper, and manganese. Wood shavings or paper pulp were used for roughages. Calves receiving paper pulp in place of shavings manifest tetany associated with low plasma magnesium. There appears to be considerable variation in the magnesium requirement of calves. Fifteen to 20 mg. of magnesium as magnesium oxide per pound of body weight maintained plasma magnesium values and prevented the manifestations of tetany. Magnesium in the form of magnesium carbonate also maintained normal magnesium values.

Eight to 10 mg. of magnesium per pound of body weight from natural foods appeared to meet the magnesium requirement as indicated by plasma magnesium values.

P18. Gross and Microscopic Pathology Associated with Low Blood Magnesium in Dairy Calves. L. A. MOORE, L. B. SHOLL, AND E. T. HALLMAN, Michigan State College.

During the past four years 35 cases of calves have come to autopsy in which the macroscopic and microscopic pathology was similar, indicating a definite syndrome. In all cases there was a previous history of low blood plasma magnesium.

Typical gross lesions were confined to the endocardium, blood vessels and diaphragmatic and splenic peritoneal surfaces. In milder cases the lesions were barely visible as slightly elevated light colored plaques 1 to 2 mm. in diameter and circular, oval or rather linear in outline. Larger more marked lesions were 2 to 5 mm. in largest diameter, variable in shape, rough and irregular on the surface and grayish white in color. In some marked cases the lesions were confluent over considerable areas. In one very extreme case the blood vessels were generally involved, and some of the smaller vessels showed marked generalized sclerosis. Many of the animals also showed variable degrees of pneumonia and nephritis.

The microscopic pathology of the white plaques noted in the macroscopic examination consists primarily of a hyaline like change which is generally basophilic when stained with alum-hematoxylin and eosin.

In the heart the lesions were confined principally to the connective tissue layer under the endothelial and subendothelial layers. In advanced cases changes have been noted in the myocardium including the Purkinje fibers.

In the larger arterial vessels in which the media consists principally of connective tissue elements, the lesions involved the media and the internal

yellow elastic membrane. In the smaller vessels where the media is made up principally of muscle cells, the lesions were confined principally to the internal elastic membrane.

The changes in the venous vessels involved the media principally, although where calcification had taken place there was erosion of the endothelium.

Microscopic lesions were present in most of the spleens examined involving the capsule and the elements of the trabeculae and in the pleural and peritoneal connective tissue elements of the diaphragm.

Extensive productive tissue changes with secondary atrophy of the parenchyma of the kidney were observed in some of these animals but whether they were related to a low blood magnesium or were due to other factors has not yet been determined.

In general the microscopic picture involved a basophilic hyaline like necrosis of the collagenous and yellow elastic connective tissue elements of the heart, blood vessels, spleen, peritoneal and pleural surfaces of the diaphragm. Further microscopic studies are in progress.

P19. Cod Liver Oil and Muscle Dystrophy in Calves. GEORGE DAVIS
AND L. A. MAYNARD, Cornell University.

In view of the published observations in this laboratory that rather moderate levels of cod liver oil produce muscle dystrophy in sheep and goats, studies were initiated to ascertain whether calves are susceptible to this same injury. Calves around two to three weeks of age were divided into three groups to receive the same three levels of cod liver oil as had been used with the sheep and goats; namely, 0.1, 0.35 and 0.7 grams per kilo. The calves were reared on skim milk, grain and good-quality mixed hay, milk being withdrawn around four to five months. One calf on the highest level of oil died after 62 days showing external symptoms similar to those exhibited by the sheep and goats which died at this level, but no evidence of dystrophy was found on post-mortem examination. The growth of the other animals continued to be excellent. One animal from each group was killed at six months of age for post-mortem studies. None of these animals showed gross evidence of injury, but microscopic evidence of mild muscular dystrophy was found in the animals receiving the two higher levels of oil. The remaining calves, all of which continued to grow normally, were killed at nine months of age. No gross evidence of muscular dystrophy was found. The histological studies are in process and the results will be reported at the meeting. It is evident from the work to date that calves are at least much less susceptible to cod liver oil injury than are sheep and goats.

P20. Effect of Phosphorus Intake on the Calcium and Inorganic Phosphorus Content of Whole Blood of Dairy Heifers During the

Periods of Gestation and First Lactation. A. H. VAN LANDINGHAM, H. O. HENDERSON, AND G. A. BOWLING, West Virginia University.

The calcium and inorganic phosphorus content of the blood of two groups of Holstein heifers have been studied during growth including the periods of gestation and first lactation. One group was fed a normal phosphorus ration while the other was fed a ration low in phosphorus. Both groups received approximately the same amount of digestible crude protein and total digestible nutrients in proportion to body weight and the amount of milk produced.

The low phosphorus ration supplying an average daily intake of 11.8 grams of phosphorus (equivalent to 1.2 grams per 100 pounds of body weight) did not have any appreciable effect on the inorganic phosphorus content of the blood during the period of first gestation. The inorganic phosphorus of the blood showed a slight decline during the later months of pregnancy. There was a decided drop in the inorganic phosphorus of the blood at or immediately following parturition which was much more pronounced in the case of the animals on the low phosphorus ration. The amount of phosphorus in the feed, the total amount of phosphorus in the milk, and changes in the body reserve of phosphorus associated with gain or loss in body weight are factors which may affect the inorganic phosphorus in the blood during lactation.

The lower level of phosphorus intake, gestation, and lactation did not have any appreciable effect on the calcium content of the whole blood.

P21. Relative Utilization by Dairy Cows of Calcium and Phosphorus in Dicapho (dicalcium phosphate) and Bonemeal (tricalcium phosphate). J. A. NEWLANDER, H. B. ELLENBERGER AND C. H. JONES, University of Vermont.

The utilization of Dicapho, a dicalcium phosphate and bonemeal, a tricalcium phosphate as mineral supplements were compared in balance trials with two pure-bred Holstein cows. These animals were fed a winter ration of timothy hay, corn silage and a suitable grain mixture, and a summer ration of timothy hay cut to one-half the usual amount, grass clippings in place of silage and a suitable pasture grain mixture. The daily allowance of mineral supplement was 100 grams. It was fed with the grain. This amount gave a large excess of calcium and phosphorus over needs. The trial ran for nearly two lactation periods, Dicapho being fed the first lactation and bonemeal the second. The milk yield of each of the rows ranged between 12,000 and 15,000 pounds per lactation.

In comparing the percentages of utilization of calcium and phosphorus in these mineral supplements it is necessary to consider the amount of intake and the amount of milk produced since the greater the intake, the lower

would be the percentage of utilization when an excess is fed and the greater the yield of milk the greater the opportunity for utilizing additional minerals for milk making over what could be stored in the body. Both of these factors favored the bonemeal rations.

With no allowance for the minerals in the excess milk and the difference in intake, the percentages of assimilation were materially higher for bonemeal than for Dicapho, the averages for the two cows being 6 per cent greater for calcium and 5 per cent greater for phosphorus. Allowing for the excess milk production when getting bonemeal, the percentage assimilation was still favorable to bonemeal by 3.7 per cent for calcium and 3.4 per cent for phosphorus. However, when allowance is made for both excess milk and amount of intake the percentage assimilation of calcium was 2.2 per cent greater for bonemeal but of phosphorus 1.1 per cent less for bonemeal than Dicapho.

Thus after making these allowances no very significant differences obtained in the assimilability of calcium and phosphorus from Dicapho and bonemeal when fed under the conditions of this trial.

P22. Body Analyses of Dairy Cows after Long Time Calcium and Phosphorus Balance Trials. H. B. ELLENBERGER, J. A. NEWLANDER, AND C. H. JONES, University of Vermont.

Three cows have been slaughtered and analyzed for their calcium and phosphorus content as a check on the results of long time balance trials.

Number 24, a pure-bred Ayrshire, though not on the balance trial herself, was analyzed as a preliminary step. She had been well fed in the University herd and at 9½ years went on a feeding trial. For one lactation she was fed timothy hay, corn silage or green grass, artificially dried grass clippings and a ¼ grain ration, producing 7,025 pounds milk and 272 pounds fat. The next lactation she received a similar ration excepting that all grain was eliminated and the intake of hay and succulence reduced, these nutrients being replaced by those from dried grass clippings. She produced 8,530 pounds milk and 332 pounds fat. The ration in her last lactation consisted only of artificially dried Sudan grass, corn silage and only 284 pounds of dried grass clippings. She produced 8,610 pounds milk and 355 pounds fat. One month after her next calving she was slaughtered and analyzed.

Number 19, a pure-bred Holstein, was started on balance trial at six years and continued thereon for six lactations or a little less than six years. She was fed timothy hay, corn silage or green grass and a well balanced grain ration plus mineral supplements during all but the first year. In these six lactations she averaged to produce 13,930 pounds milk and 465 pounds fat. At the time of slaughter five days after calving she had accumulated positive balances of 5,123 grams calcium and 6,192 grams phosphorus.

Number 101, a pure-bred Holstein, went on balance trial when four years old. She was fed practically the same as Number 19 but without mineral supplements. She was on trial 2½ years, being slaughtered after milking 24 weeks in the third lactation, by which time her balances were -764 grams calcium and + 2,674 grams phosphorus. During the two full lactations and the 24 weeks of the third she produced 15,100, 14,300, and 10,060 pounds milk and 504, 498 and 336 pounds fat.

The following table sets forth results of the analyses for cows 24 and 19. Data for 101 will be available at the time this paper is presented.

Calcium and Phosphorus in Cow's Body

	WEIGHT KGS.	GRAMS CA	% CA	GRAMS P	% P	RATIO CA/P
<i>Cow 24</i>						
Empty weight	449.0	7102.1	1.58	3676.6	.82	1.93
Contents of digestive tract	64.9	101.1	.16	106.6	.16	.95
Green bones	68.9	7026.9	10.20	3219.0	4.67	2.18
Fat-free empty weight	387.5	7102.1	1.83	3676.6	.95	1.93
“ “ green bones	54.8	7026.9	12.82	3219.0	5.87	2.18
“ “ soft tissues	297.9	72.6	.02	453.1	.15	—
“ “ hide and hair	38.7	8.7	.02	12.5	.03	—
“ “ carcass meat	211.2	37.4	.02	343.8	.16	—
“ “ blood	25.8	2.6	.01	4.6	.02	—
“ “ intestinal tract	34.6	24.4	.07	59.7	.17	—
“ “ other organs	13.4	2.1	.02	37.1	.28	—
<i>Cow 19</i>						
Empty weight	437.6	7775.4	1.78	4009.3	.92	1.94
Contents of digestive tract	63.6	80.3	.13	78.4	.12	1.02
Green bones	69.4	7668.4	11.05	3552.0	5.12	2.16
Fat-free empty weight	365.2	7775.4	2.13	4009.3	1.10	1.94
“ “ green bones	49.9	7668.4	15.37	3552.0	7.12	2.16
“ “ soft tissues	287.3	104.2	.04	453.6	.16	—
“ “ hide and hair	31.8	8.7	.03	9.4	.03	—
“ “ carcass meat	200.3	43.8	.02	339.6	.17	—
“ “ blood	28.1	2.8	.01	3.7	.01	—
“ “ intestinal tract	40.2	80.3	.20	78.4	.20	—
“ “ other organs	15.0	2.5	.02	35.8	.24	—
<i>Cow 101</i>						
Empty weight	371.4	6086.9	1.64	3476.5	.94	1.75
Contents of digestive tract	81.2	51.9	.06	60.2	.07	.86
Green bones	60.5	5983.6	9.89	2974.0	4.92	2.01
Fat-free empty weight	337.6	6086.9	1.80	3476.5	1.03	1.75
“ “ green bones	48.1	5983.6	12.44	2974.0	6.18	2.01
“ “ soft tissues	289.5	100.6	.03	496.5	.17	—
“ “ hide and hair	31.2	15.6	.05	18.7	.06	—
“ “ carcass meat	169.5	35.4	.02	348.0	.21	—
“ “ blood	24.4	2.8	.01	6.0	.02	—
“ “ intestinal tract	49.1	46.8	.10	83.9	.17	—
“ “ other organs	15.3	2.8	.02	45.9	.30	—

P23. The Influence of Roughage on the Vitamin D Potency of Milk.

G. C. WALLIS AND T. M. OLSON, South Dakota State College.

Three lots of two grade Holstein cows each were used on this experiment. The cows were weighed monthly, fed according to the feeding standard, and exercised after sundown twice weekly in favorable weather. The grain mixture was made up of corn, oats, corn gluten meal, salt, and bone meal.

Starting with December 15 all the animals received beet pulp for roughage for two months to deplete them of vitamin D and standardize them for the experiment proper. Following this, two cows were continued on this ration for the check group, two were given 20 pounds of alfalfa hay each, and two others the same amount of prairie hay. Puratene, containing only one Steenbock unit of vitamin D in 8 grams was used to supply vitamin A to the check lot. The two lots of hay used were of similar curing history and of known vitamin D potency. The vitamin D potency of the milk was determined by running biological assays on the rendered butterfat from aliquot milk samples saved over 3 to 5 day periods. Fat samples were collected for preliminary trials in April, July and November previous to the beginning of the experiment proper and while the cows were receiving regular herd management. Another sample was obtained from all six cows after the two months depletion period. Additional samples were secured from each of the three groups after they had been on their respective experimental roughages for 30, 60, and 90 day intervals. Total calcium and inorganic phosphorus determinations on the blood plasma of the cows were made on three day composite samples at 30 day intervals. Two day aliquot samples of milk were also taken from each animal at 30 day intervals for fat, total solids, ash, calcium and phosphorus determinations.

The vitamin D assays on the preliminary samples taken while the animals were still under normal herd management showed that for one Steenbock unit it took 12.0 grams of the April fat, 3.2 grams of the July fat, and 9.6 grams of the November fat. The fat taken in February at the close of the two months depletion period was so impotent that healing was not initiated by the largest amount that the rats would consume. Neither was it possible to measure directly the vitamin D potency of the fat samples collected 30 days after the hay feeding was started. However, some of the rats receiving the highest level of fat from the alfalfa fed group showed slight healing, indicating that it might be more potent than the fat from the prairie hay group. This would harmonize with the observation that one Steenbock unit of vitamin D was contained in 3 grams of the alfalfa hay, whereas it took 6 grams of the prairie hay. Attempts are now being made to concentrate the vitamin D in alcohol extractions of the fat.

The blood analyses have been normal but for two exceptions. A heavy-milking cow on the alfalfa hay roughage has shown a decline in inorganic phosphorus to somewhat subnormal levels. One cow in the check group completed a lactation and freshened again after four months on the vitamin D deficient ration. She gave birth to a fine, vigorous calf, but two days after parturition she became paralyzed and was unable to get up. Blood samples taken at this time showed only 5.34 mgm. of calcium and 3.13 mgm. of phosphorus per 100 cc. of plasma. Two days after cod liver oil administration she was on her feet again and the plasma showed 7.77 mgm. of calcium and

3.66 mgm. of phosphorus per 100 cc. Milk samples were also taken at this time but have not been analyzed as yet. The other milk analyses have not varied appreciably from normal.

P24. A Further Study of the Factor in Soybeans Affecting the Vitamin A Value of Butter. J. W. WILBUR, S. M. HAUGE, AND J. H. HILTON, Purdue University.

It has been found in previous experiments that soybeans in rations of dairy cows have a suppressing action on the formation of vitamin A in the butter. It has also been found that the factor in soybeans responsible for this suppressing action is not affected by heat. Further experiments have been conducted for the purpose of determining what component part or parts of the soybean carry this factor.

When soybean oil, obtained either by expeller or solvent process was added to the check ration there was a marked suppression of vitamin A activity in the butterfat. Commercial soybean oil meal with relatively low fat content also contained the factor. Soybeans extracted with both ether and alcohol were somewhat superior to the expeller process soybean oil meal. An alcoholic extract of ether extracted soybeans did not contain the factor.

The fact that fat free soybeans still possess this active agent together with the fact that linseed oil had only a slight suppressing action on the vitamin A activity of the butterfat indicates that the soybean oil itself is not responsible for this suppressing action but that it is due to some other factor.

P25. The Rate of Change in the Vitamin A Content of Milk. W. C. LOY, J. H. HILTON, J. W. WILBUR, AND S. M. HAUGE, Purdue University.

Studies have been made of the rate of change in the color value, carotene, and vitamin A content of the milk from two cows following a change from a high vitamin A ration to a low vitamin A ration and vice versa. Alfalfa hay was the principal source of vitamin A in the high vitamin A ration, while timothy hay was the principal source of vitamin A in the low vitamin A ration.

When the cows were changed from the high vitamin A ration (alfalfa hay) to the low vitamin A ration (timothy hay) the color value, carotene, and vitamin A content of the milk dropped rapidly reaching an equilibrium for this particular ration in about 11 days after the change was made. When the cows were changed from the low vitamin A ration to the high vitamin A ration the color value, carotene and vitamin A content of the milk increased rapidly, reaching an equilibrium in about 10 days.

The results of these feeding trials would indicate that the major effect of a change in the ration upon the vitamin A content of cows' milk can be ascertained by relatively short feeding trials.

P26. Site of Synthesis of Fat in the Mammary Gland. PHILIP KELLY
AND WM. E. PETERSEN, University of Minnesota.

Sections of mammary glands fixed in 10 per cent formaldehyde and physiologic saline solution were stained with dyes differentiating neutral fat and free fatty acids. Five such stains were used: Nile blue sulphate, neutral red, Osmic acid, Sudan and brilliant Cresyl blue. Sections were examined under high magnification and all methods were positive to free fatty acids in the basal part of the epithelial cell fading out toward the lumen. No evidence of free acids was found in the alveolus.

Ether and alcohol extract of the gland tissue indicated free fatty acid to the extent of 4 to 5 per cent of the total lipide extract of the gland tissue, calculated in terms of oleic acid.

The free fatty acids were isolated and the volatile fatty acids determined by the Reichert-Meissl method. These values were approximately twice that of normal butterfat.

P27. Galactin Content of Pituitaries. R. P. REECE AND C. W. TURNER,
University of Missouri.

Investigations during recent years have indicated that the hormone, galactin, is the initiator of lactation. While there is no direct evidence indicating that galactin plays a part in maintaining lactation, there is indirect evidence upon this subject.

It was thought that additional information might be thrown upon the physiology of lactation by determining the galactin content of pituitaries. Consequently cattle pituitaries have been collected in a local slaughter house. One of us has always been present when the animals were slaughtered and data were recorded which enabled us to classify the pituitary glands according to the age, sex, stage of the reproductive cycle and stage of lactation of the animals. These pituitary glands have varied considerably in weight. The following table gives a summary of the weights of the glands.

While cattle pituitaries will enable us to study some of the factors influencing the galactin content of these glands it will be nearly impossible to obtain a sufficient number of pituitary glands at the most critical stages. For such additional information we have been working with a laboratory animal, the albino rat. We have been able to detect galactin in one normal male rat pituitary and at the present time we are studying the influence of estrone, thyroxine, pregnancy and lactation upon the galactin content of the rat pituitary gland.

TABLE 1
The weight of the bovine pituitary

GROUP	NO. OF GLANDS	MEAN IN GRAMS	MAXIMUM IN GRAMS	MINIMUM IN GRAMS
<i>Fetal</i>	30	0.0303	0.1656	0.0005
— to 140 days	19	0.0278	0.0726	0.0005
141 to 283 days	11	0.0623	0.1656	0.0060
<i>Calf</i>				
Up to and including 3 months	12	0.7361	0.9175	0.5900
4 months to and including 10 months	117	0.8941	1.3441	0.3412
<i>Heifers</i> —None included that were sexually mature	69	0.9005	1.3164	0.5969
<i>Steers</i>	30	0.8842	1.3441	0.5951
<i>Bulls</i>	18	0.8859	1.2694	0.3412
11 months to and including 23 months	74	1.1372	1.7666	0.6690
<i>Heifers</i>				
Open	34	1.1794	1.7666	0.7796
Pregnant	20	1.0733	1.4750	0.7434
<i>Steers</i>	14	1.1330	1.5082	0.6690
<i>Bulls</i>	6	1.1209	1.3469	0.9383
<i>Cows</i> —2 years and over	42	1.8193	2.7786	0.7431
Dairy	32	1.7820	2.7786	0.7431
Beef	10	1.9386	2.5389	1.3733
Open	30	1.8624	2.7786	1.1076
Pregnant	12	1.7115	2.3431	0.7431
Dry	22	1.6758	2.7786	1.1076
Milking	20	1.9771	2.6218	0.7431

P28. Bovine Ovarian Reactions to Various Gonadotropic Hormone Preparations. L. E. CASIDA, University of Wisconsin.

Heifer calves 1-3 months of age have been injected with various dosages of sheep anterior pituitary extract and pregnant mare blood serum. Table 1 summarizes the quantitative and qualitative responses of the calves' ovaries.

TABLE 1
Response of Holstein heifer calves to pregnant mare serum and anterior pituitary extract

NO. OF CALVES	HORMONE PREPARATION	TOTAL DOSAGE RAT UNITS	NO. DAYS INJECTED	AVG. OVARIAN WT., GMS.	CALVES SHOWING	
					Follicles only	Ovulation papillae
190	Normal uninjected			1.9 ± 0.09		
7	P.M.S.	126 ± 30	6	5.9 ± 1.6	3	4
6	A.P.	50 ± 19	6	13.3 ± 4.5	6	0
3	A.P.	50-60	11-12	13.8	1	2

Five cc. of the hormone preparation were injected subcutaneously once daily and the ovaries were observed on the day following the last injection.

The data indicate that anterior pituitary extract does not bring about ovulation as quickly as pregnant mare serum, but the increases it produces in weight of the ovaries is greater with even smaller rat-unit dosages.

TABLE 2
Response of mature cows to pregnant mare serum and anterior pituitary extract

NO. OF COWS	HORMONE PREPARATION	TOTAL DOSAGE RAT UNITS	AVG. OVARIAN WT., GMS.
20	Normal	uninjected	18.0 \pm 1.2
2	P.M.S	32	15.7
13	A.P.	32	77.9 \pm 10.5

The difference in quantitative response is also seen in the ovaries of mature cows which had been injected for four days and ovaries examined on the sixth day (Table 2). Thirty-two rat units of anterior pituitary extract gave 400% increase in the weight of the ovaries on the average, whereas the indications are that the equivalent dosage of pregnant mare serum produces little or no noticeable effect. The latter is in keeping with Hart and Cole's observation that 750 rat units of pregnant mare serum is an approach to a minimal dose to elicit a response in the mature cow.

P29. Comparisons of Arterial and Mammary Venous Bloods as Related to Milk Secretion. W. R. GRAHAM, JR.,* University of Missouri and National Institute for Research in Dairying, Shinfield, Reading, England.

Two methods by which arterial blood may be obtained for chemical comparison with mammary venous blood are described. The results from a large number of analyses of bloods taken from an artery and the mammary vein show that the time relationships of the two bleedings may influence greatly the values found for various constituents on analyses. These results indicate that certain fixed criteria must be applied in experiments of this nature if the results are to be interpreted as related to the process of milk secretion.

An attempt has been made to combine this type of experiment with measurements of the volume flow of blood through the mammary gland by the thermo stromur method as a technique for study of the nutrition of the mammary gland. This is described and some results are given.

P30. Effect of Hypophysectomy on Development and Function of the Mammary Gland. E. T. GOMEZ AND C. W. TURNER, University of Missouri.

For many years the activity of the mammary gland has been assumed to be governed first by internal secretions or hormones of ovarian origin because

* Fellow of National Research Council in Biological Sciences.

of the relationship between mammary gland growth and reproductive activity and the repeated demonstrations of mammary gland growth following ovarian hormones (estrogenic and corpus luteum hormones) administration, and second by a secretion of pituitary origin as indicated by the experimental initiation of lactation in properly conditioned mammary glands by an extract of the hypophysis containing the lactation promoting principle. During recent years, however, the evidence accumulating in the studies with hypophysectomized animals seemed to indicate the existence of a reciprocal relationship between the pituitary, ovaries, and other endocrine glands in the control of normal growth and development and function of the mammary glands.

The daily injection of estrogenic hormones, theelin (aqueous and in oil) or the benzoate of dihydrotheelin in varying amounts ranging from 25 to 1000 I.U. on a number of hypophysectomized males and young female laboratory mammals in our laboratory, including the rat, mouse, guinea pig, and a single case of cat and rabbit for periods ranging from 20 to 90 days did not stimulate the growth of the glandular parenchyma. Likewise, daily simultaneous injections of 100 I.U. of theelin (in oil) and 1/5 rabbit unit of corpus luteum hormone for 20 days did not stimulate mammary gland growth in hypophysectomized young males and multiparous involuted female guinea pigs. In contrast to our observations, some investigators have reported the stimulation of mammary gland growth by the injection of estrogenic hormone alone and in combination with the corpus luteum hormone in hypophysectomized guinea pigs, rats and rabbits.

In experimentally cryptorchid and unilaterally castrated male guinea pigs carrying functional ovarian grafts from 6 to 8 weeks, the removal of the testis-grafts or the injection of lactogenic hormone, galactin, is followed by copious milk secretion within 48 to 60 hours. Hypophysectomy in this type of animals immediately before the injection of galactin, or at the time of the removal of the testis-grafts, prevented the initiation of lactation. Lactating female guinea pigs hypophysectomized at any stage during the lactation period declined rapidly in milk secretion, being completely dry in 2 to 3 days. Rats and mice hypophysectomized late in pregnancy or at any time during the lactation period either prevented the initiation or caused rapid decline and complete cessation of lactation. Daily injections of 10 to 50 mgs. of galactin immediately after hypophysectomy in lactating guinea pigs did not re-initiate the secretory activity of the mammary gland or prevent the rapid decline and cessation of lactation, respectively. Similar observations were obtained in three cats hypophysectomized during the lactation period. Lactation corresponding to the normal extent of the lactation period was maintained in guinea pigs by the daily injection of an aqueous suspension of ground whole pituitary gland of the sheep beginning at the time of hypophysectomy. Two goats giving an average of 3 pounds of milk daily declined

in production to 15 cc. on the second day after hypophysectomy. In one of these animals the injection of 100 mgs. of galactin administered twice daily for five days did not increase milk production. However, the production of both animals increased very slowly one week after the operation so that by the end of the second week they were giving from 150 to 200 cc. of milk daily which was maintained practically constant throughout the course of an observation period of about 3 months. At autopsy one of the animals was found to be incompletely hypophysectomized. While the level of production of these animals did not return to normal, it is evident that the fragments of pituitary tissue left were able to maintain the continuance of lactation.

These observations are believed to emphasize further the reciprocal pituitary-ovarian relationships with respect to the growth and development of the mammary gland and the importance of the products of other endocrine glands controlled by the hypophysis in lactation.

P31. The Vitamin A Content of A.I.V., Molasses and Normal Silage and the Effect of Feeding These Silages upon the Vitamin A Content of Milk. I. L. HATHAWAY, H. P. DAVIS, AND J. C. BRAUER, University of Nebraska.

A study was made of the vitamin A content of the A.I.V., molasses and normal corn silage. The silages were fed to groups of cows and the vitamin A content of their milk determined. The vitamin A determinations were made by feeding the silage or the milk to groups of rats whose body stores of this vitamin had been depleted by being fed a vitamin A deficient ration. Approximately 670 rats were used in these experiments. There were no apparent ill effects of feeding as much as 3.2 grams of A.I.V. silage per rat per day for 8 weeks. This was 20 to 30 per cent of the food consumed. The A.I.V. silage contained only slightly more vitamin A than did the molasses silage. The normal silage was decidedly inferior to either A.I.V. or molasses silage in vitamin A content.

Milk produced by cows receiving these silages as the only source of roughage ranked in the same order of vitamin A potency as did the silages namely, A.I.V. silage milk, molasses silage milk and normal silage milk. On the other hand when a good grade of alfalfa hay served as the only source of roughage, the vitamin A content of the milk produced contained more vitamin A than did the milk produced by cows receiving A.I.V. silage as the only roughage. When both alfalfa hay and A.I.V. silage were fed as the roughage and the amount of alfalfa hay consumed by the cows was less than that consumed by a comparable group on alfalfa hay and molasses silage, the vitamin A content of the milk produced was greater in the milk of the group receiving the molasses silage.

P32. Studies on A.I.V. Silage. Part I—Preparation and Feeding.

C. F. MONROE AND C. C. HAYDEN, Ohio Agricultural Experiment Station, Wooster.

First cutting alfalfa, containing some clover and timothy, was cut into approximately inch lengths and run into a wooden silo. During the filling process a two normal mixture of hydrochloric and sulphuric acid was sprayed onto the cut material. Approximately 20 gallons of the acid mixture were added per ton of green material. Previous laboratory trials had shown that the acid should be added at this rate to obtain a desired pH of 3.5 in the resulting silage. The filling was completed on June 13, 1935. The silo was immediately "topped" by running in 2300 pounds of chopped green alfalfa (without acid), covering with tar paper, and finally with dry wood shavings to a depth of four inches. When the silo was opened on October 21 there were approximately 1000 pounds of spoiled material on top which was mostly non-acid alfalfa. The remaining silage proved to be of excellent quality with practically no spoilage and it has been quite palatable to the cows. The pH of the silage has averaged 3.67.

The original plan of this work called for cutting and feeding one-half of the field as A.I.V. silage and the other half as hay. However, due to heavy rains and poor curing weather, the hay crop was lost. It then became necessary to change the plan to the extent of comparing the A.I.V. silage with first cutting straight alfalfa, which was purchased.

The actual feeding work was conducted as follows: Group A, which consisted of 4 cows, was fed the A.I.V. silage as the only roughage, straight through the winter feeding period. Group B, which consisted of 4 cows was fed the first-cutting alfalfa hay, as the only roughage straight through. Groups C and D, consisting of 7 cows each, were used in a reversal trial. A.I.V. silage and first cutting alfalfa were alternated; while corn silage was fed in like amounts to both groups.

All cows received the same grain mixture fed in accordance with production. Finely ground limestone and a very small amount of potassium iodide were also fed.

The results of this trial in terms of milk and butterfat production and liveweight gains indicate that A.I.V. silage may be substituted for dry hay. In fact, the production was a little greater on the A.I.V. silage than on the hay ration. Most of this increase may be accounted for on the basis of a greater feed intake on the A.I.V. ration. The A.I.V. silage did not show any unusual milk-producing properties.

P33. Studies on A.I.V. Silage. Part II—Nutrient Preservation and Physiological Effects on the Cow. A. E. PERKINS AND C. F. MONROE, Ohio Agricultural Experiment Station, Wooster.

Samples of the crop taken at the silo averaged 33 per cent air-dry matter. Twenty (20) gallons per ton or approximately 1200 gallons of 2 N acid solu-

tion was added. The average air-dry matter of 10 samples taken throughout the winter was 30 per cent.

The pH of the acid solution added was 0.35; that of the juice draining from the silo, 3.29, and the average value for the silage was 3.67.

The total loss of juice (mostly measured) was 150 gallons or about one-eighth the volume of liquid added.

The total loss of crude protein in the juice was about 10 pounds or 0.17 of 1 per cent of the protein contained in the silage. The loss at the surface of the silo was only 1000 pounds after 4 months' summer exposure, although only a very simple seal of paper and wood shavings was used.

The silage was fed to one group of 4 cows as the sole roughage over a period of 160 days and to other groups of cows in connection with corn silage for shorter periods. Four (4) ounces of limestone was fed daily to each cow receiving A.I.V. silage.

The urine became much more acid in reaction. The bicarbonates practically disappeared and the ammonia increased from 10- to 150-fold.

The CO₂ capacity of the blood was decreased, but not to an alarming extent. This effect did not seem to be cumulative, and there was no noticeable effect on the condition or well-being of any of the cows.

Alfalfa hay fed in connection with the A.I.V. silage was much more effective in restoring the urinary reactions toward normal than was the ground limestone commonly fed for that purpose.

P34. Studies on A.I.V. Silage. Part III—Carotene Preservation, and Biological Properties of the Milk. W. E. KRAUSS AND R. G. WASHBURN, Ohio Agricultural Experiment Station, Wooster.

The average carotene content of the alfalfa in the field was 180 gamma per gram (air dry basis). By the time the crop had been hauled to the silo and chopped the carotene had dropped to 130 gamma per gram (air dry basis). Eleven determinations made as the material was fed out of the silo showed the A.I.V. to contain, on the average, 219 gamma of carotene per gram (air dry basis). The concentration of carotene in the upper part of the silo approximated that of the field samples, but as the bottom of the silo was approached the carotene concentration increased. That more carotene was found in the A.I.V. silage than in the original crop can probably be explained at least partly by the more complete extraction of carotene from acid-treated material. Hay made from the same field exposed to several rains contained about 22 gamma of carotene per gram (air dry basis). The preservation of carotene in the A.I.V. silage was, therefore, of considerable magnitude.

Samples of butterfat were obtained from the individual cows in the all-through and the reversal feeding experiments referred to in Part I. All the

samples were subjected to carotene determinations, using a Lovibond tintometer standardized against solutions of pure carrot oil. The carotene in the fats from two Jerseys and two Holstein in each of the feeding trials was determined spectrophotometrically.* From the results summarized in the following tables it is apparent that the carotene values for the roughages, obtained chemically, were reflected in the carotene content of the fat produced. The hay fed contained 7.2 gamma of carotene per gram and the corn silage 52 gamma per gram, both on an air dry basis.

Carotene concentration in butterfat produced by cows fed all hay or all A.I.V. continuously (Mg. per Kg.)

COW AND BREED	BEGINNING	AFTER 30 DAYS	AFTER 63 DAYS	AFTER 120 DAYS	AFTER 150 DAYS
<i>All hay</i>					
H 352	3.20	2.20	2.28	2.66	1.70
H 442	4.60	2.28	1.80	3.12	2.01
J 385	11.60	3.65	4.46	Dry	Dry
J 398	12.20	3.24	2.58	3.46	3.22

All A.I.V.

H 386	4.35	6.27	6.50	9.60	7.30
H 430	3.40	6.20	6.85	7.55	4.96
J 393	5.12	6.94	6.65	3.34(?)	Dry
J 477	10.08	9.97	8.20	10.05	6.86

Carotene concentration in butterfat produced by cows fed hay and corn silage or A.I.V. and corn silage and reversed (Mg. per Kg.)

COW AND BREED	BEGINNING	END OF FIRST PERIOD	END OF SECOND PERIOD
		<i>Hay</i>	<i>A.I.V.</i>
H 346	3.08	3.14	7.48
H 465	2.12	2.57	5.44
J 437	4.32	2.02	11.75
J 453	1.59	3.36	7.44
		<i>A.I.V.</i>	<i>Hay</i>
H 343	4.84	6.05	3.04
H 476	†	5.85	2.74
J 373	3.22	8.60	2.12
J 435	4.52	8.05	4.32

Milk from the all-through groups was mineralized and fed to pairs of rats, one rat of each pair receiving milk from the A.I.V. cows and one milk from the hay cows. Very slightly better responses were obtained with A.I.V. milk

* Courtesy of the S. M. A. Corporation, Cleveland, Ohio.

in three series involving 20 pairs fed according to the paired feeding system and 8 pairs fed ad libitum.

Milk from the hay cows was found to contain more vitamin D and somewhat more of the vitamin G complex. No difference was found in the vitamin C content of the milk produced on the various rations. The surplus of vitamin C obtained from A.I.V. silage was excreted in the urine.

P35. Photographic Techniques as Applied to the Dairy Industry.

R. F. MORGAN, University of Nebraska.

The standard of photographic illustrations in most of our scientific magazines is low. A recent survey of nearly 4,000 photographs which appeared in medical journals showed that 24% of the illustrations were poor; 34% were only fair and 42% were good or excellent. The photographs were of low standard because many of them were taken by workers who had little or no knowledge of the principles of photography. As a result much loss of detail was encountered in the preparation of cuts.

Good photography, regardless of the profession, requires a thorough understanding of the mechanism of the camera in use, unlimited patience, a broad knowledge of photography and the skill to apply the information to the subject.

Photography of a technical nature is usually made by artificial light or under adverse conditions so it is often difficult to get good results. Failure may be due to many conditions. The use of an inferior lens may cause distortion of the subject, spherical abbreviation, chromatic abbreviation or some other fault of this nature. Failure to obtain good photographs is often due to lack of critical focus on the subject. Or it may be due to under exposure. The use of a high grade light meter will greatly improve the quality of all kinds of photographs. Satisfactory tones cannot be produced without an understanding of the use of light. Correct lighting will give depth and modeling to an otherwise flat picture. Avoid including too many objects in one picture. Simplicity is always an important point to consider in composing the picture. For exposures over 1/25 of a second, the camera should be placed on a substantial tripod or on some solid base to avoid vibration.

There are many applications of photography in dairy science. One very practical application in vitamin D assay work has been developed in the Department of Dairy Husbandry at the University of Nebraska. Longitude sections of tibia bones from rats having received vitamin D milk or bread are photographed through a specially constructed camera. The rat bones can be enlarged seven to eight diameters and eight sections of rat bones occupying a space approximately one inch long by three-fourths inch in width can be enlarged to fill a 5 × 7 film. By this method the bones can be photographed direct without enlarging from a small negative.

The original camera for this work has a double bellows extension twenty inches in length from lens to film. To this camera is attached a wooden box 38½ inches long. This gives a complete bellows extension of approximately 58" from lens to film. It has also been necessary to arrange masks inside the wooden box to prevent reflections. Fine detail can be obtained in the enlargement of small objects by the use of this technical camera.

The use of photography in the breeding program and in the studies of growth at the University of Nebraska in their herd of dairy cattle has also proven to be a valuable asset in studying the progress made in these lines of endeavor. Animals are photographed monthly and all pictures are taken on the same scale against a barred background. The pictures obtained by this system are an excellent source of information which could hardly be presented by any other method of record keeping. When the animals are properly posed records of this nature afford an indisputable story of the growth and appearance of the animals from infancy to maturity.

P36. Alignment Charts for Estimating Profit Per Cow and Per Unit Milk. S. BRODY AND A. C. RAGSDALE, University of Missouri.

About a year ago we published an alignment chart for estimating the energetic efficiency of milk production, that is, the percentage ratio of energy in milk produced to energy in TDN consumed (see Missouri Station Bulletin 351). Energetic efficiency of milk production is the best index of dairy quality or "productive efficiency" inasmuch as it is independent of extraneous circumstances such as size of cow, prices of milk and feed, etc. However, a demand developed for a similar chart for estimating profit, and it is the purpose of this paper to present two kinds of such profit charts.

Both of these are called alignment or nomograph charts, the construction of which is too technical for discussion at this time. However, the use of the charts for estimating profit is simple. A numerical example is written out on each chart and the method of solving it is indicated by broken guide lines.

To use the first and apparently simpler chart, it is first necessary to evaluate energetic efficiency of the cow by the method given in Missouri Station Bulletin 351. Knowing energetic efficiency, milk production, feed and milk prices then profit per 1,000 pounds FCM and per cow is read from the chart as illustrated by the numerical example thereon, and indicated by the broken guide lines.

To use the second and apparently more complicated chart, it is not necessary to have the energetic efficiency. Only live weight, milk production, prices of milk and TDN are needed to estimate profit.

In both cases, the milk of the given fat per cent must be converted to Gaines' FCM (4% milk) before carrying out the estimation. (Missouri Station Bulletin 351 presents a simple method for making the conversion from milk to FCM.)

P37. A Lesson in Feeds. R. B. BECKER, University of Florida.

Study of feeds is simplified by classing them into groups that have common characteristics. This plan saves time in study to fix in mind the nutrient qualities of feeds. Such a method was presented in Oklahoma Extension Circular 246, patterned after earlier publications and has been used in "Feeds and Feeding" classes. The text "Feeds and Feeding," by Henry & Morrison, is supplemented with bulletins and selected references. Each student is supplied with a paper 17×22 inches on which he enters headings regarding chemical composition (Appendix Table 1), coefficients of digestibility of dry matter (Table 2), the digestible crude protein and total digestible nutrients (Table 3), net energy value in therms (Table 6), and average calcium and phosphorus *percentages*, supplied subsequently by the instructor.

In the left column, each student lists certain major classes, and allows for 3 or more feeds under each, and average values for each class of feeds. This suggested classification follows:

Concentrates

Starchy grains and seeds—No. 2 corn, oats, barley

High-protein oil seeds—cottonseed, flax, peanuts, soybeans

Industrial and milling by-products—bran, corn gluten meal, beet pulp, etc.

High-protein oilmeals—cottonseed, linseed and soybean oilmeals

Molasses—blackstrap

Animal by-products—skimmilk powder, tankage, fishmeal

Bulky Feeds

Grass hays—timothy, Sudan, natal grass

Legume hays—alfalfa, cowpea, peanut

Low grade roughage—oat straw, corn cob, cottonseed hulls

Silages from grasses—corn, sorghum, sugarcane

Silages from legumes—soybean, peavine cannery silage

Root Crops—mangles, turnips, potatoes, sweet potatoes

Each student fills in his chart from the tables designated and the additional references. When the chart is completed, he receives a set of study questions which constitute a regular examination. Typical questions include:

1. Compare the composition of starchy grains with high-protein oil seeds. How do these differences affect their use in rations?
2. Rank the groups of feeds from low, to high, in fiber content.
3. What relationship appears to exist between percentage of fiber and coefficient of digestibility of dry matter in starchy grains, grass roughages and root crops? With which group may the dry matter of root crops have a similar feeding value?
4. In general, how do concentrates compare with roughages in T. D. N. values?

5. Explain possible causes of lower net energy value per pound of T. D. N. in low grade roughages, as compared with grass hays and with starchy grains.
6. Explain the high T. D. N. value of the high-protein oil seeds.
7. Are grass and legume hays similar in feeding value to silages from similar crops, when calculated on a dry matter basis?
Use any accessible reference in answering these questions.

To round out use of this chart, Kellner's calcium and phosphorus standard for dairy cows is used when estimating adequacy of rations in these elements.

Placing feeds in classes for combined study facilitates an understanding of the characteristics and nutritive properties of individual feeds, and brings local feeds and feeding problems into closer relation with established general practices.

P38. Production of Dairy Cows when Fed only Silage and Cracked Soybeans. N. K. WILLIAMS, C. Y. CANNON, AND D. L. ESPE, Iowa State College.

Four pairs of dairy cows in the early stages of lactation were selected from the station herd and divided into two lots consisting of one cow from each pair.

After a ten-day transition phase one lot was put on a ration consisting of silage fed *ad libitum* and cracked soybean grain fed at the rate of approximately one pound for every five pounds of milk produced. A mineral mixture composed of equal parts of steamed bone meal and common salt was available at all times. The other (check) lot was fed a standard ration of silage, alfalfa hay, and a grain mix made up of 4 parts yellow corn, 4 parts oats, 1 part soybean oil meal, 1 per cent salt and 1 per cent bone meal, and fed at the rate of approximately one pound of grain for every three pounds of milk produced.

During the five months of the trial both lots of cows were in good health and produced milk and fat at about the same rate. The fat tests of the experimental cows were normal except for a short period at the beginning of the trial when milk production was a trifle low and the fat test correspondingly high.

Chemical analyses of periodic samples of milk taken from the two lots showed that the iodine number of the fat from the cows fed silage and soybean grain had a mean of 40 as compared to a mean of 30 for the fat from the check lot. Likewise, the Polenski number was about 2.3 as compared to 3.3 for the fat from the check lot. The Reichert-Meisel values fluctuated somewhat, but the averages for the two lots were about the same. The protein values of the milk produced by the two lots showed no particular change from each other.

P39. Methods of Making Grass Silage. T. E. WOODWARD, Bureau of Dairy Industry, U. S. D. A.

The objects of this work were to find the methods best adapted for making grass silage in ordinary tower silos. Answers were sought to the following questions: Should the grass be chopped before it is placed in the silo? What is the influence of the moisture content and of the maturity of the crop upon the quality of the silage? Can grasses that ordinarily make a poor quality of hay be better utilized by putting them in the silo? What are the advantages, if any, of adding dilute acids or molasses to the material as it is placed in the silo?

The efficiency of the different methods was determined by the quantity which could be put in a silo of a given size, the extent of spoilage, the loss of nutrients, the temperatures attained, and the appearance, odor and palatability of the silage.

Wooden stave silos 4 feet in diameter and 8 feet high were used. In order to more nearly simulate conditions in a deeper silo, weight was always applied as soon as the filling was completed. This weight was at the rate of 40 to 45 pounds per square foot of surface. Altogether 19 fillings in the last 3 years are represented in this study.

Chopping permits more material to be stored in a given space, reduces the spoilage, and makes the silage more palatable. Partial drying makes the material easier to handle, increases the quantity of dry matter that can be stored in a given space, does not impair the palatability, but may increase the surface spoilage. Immature grass makes a better silage than more mature grass. Unpalatable grass will not make a palatable silage. Good grass silage is quite palatable; cows will eat as much of such silage as they will graze of the grass from which the silage is made. Exclusive of surface spoilage, the losses of dry matter are very small. The preservation of protein appears to be almost perfect. Grass silage properly made has a high content of carotene. With fine cutting and close packing the temperatures can easily be kept well below 100° F. The addition of acid may reduce slightly the loss of carotene, but on the other hand, it may affect the palatability adversely. It is not believed possible for the acid to bring about sufficient improvement to justify its use. A single trial with the addition of molasses fails to disclose any particular advantage in using molasses. Unlike acid, however, molasses does furnish valuable food nutrients, and it is not destructive to clothing and to the silos themselves.

P40. Sweet Potatoes Versus Silage for Milk Production. R. H. LUSH,* Louisiana Agricultural Experiment Station.

Having in mind the small Southern farmer with too few cows for any type of silo, but with facilities for raising more sweet potatoes than necessary

* Credit is due Superintendent Sidney Stewart, North Louisiana Experiment Station, for aid in the first and fourth tests, and Professor C. H. Staples, Louisiana State University, for the second and third tests.

for home use, we have been making feeding reversal tests with potatoes and silage. Chopped sweet potatoes were fed at the rate of two pounds per hundred pounds live weight. Silage was fed at twice that rate. The same kind of high protein grain and hay has been used. Jersey and small Holstein cows were used. Results are given in terms of four per cent fat corrected milk.

In the first test, a net increase of 10.3 per cent milk was obtained for sweet potatoes over sorgo silage in two 35-day periods. Two hundred and forty pounds of silage were required to equal 100 pounds of sweet potatoes. With silage at \$4.00 per ton, this gives a feed replacement value of \$9.62 for sweet potatoes. In a second comparison which covered two 30-day periods, an increase of 10.4 per cent milk was obtained for the sweet potatoes over corn and soybean silage, and 256 pounds of silage were required to equal 100 pounds of sweet potatoes. In a third comparison, also with corn and soybean silage, sweet potatoes produced 5.62 per cent more milk during two 40-day periods. One hundred pounds sweet potatoes replaced 258 pounds of silage. In the fourth test, sorgo silage was used again for two 50-day periods. A part of the potatoes were frozen and quality impaired during the latter part of the test. However, 1.37 per cent more milk was produced during the sweet potato periods.

The average of the four tests gave 6.93 per cent increase, or 2.08 pounds more milk per cow daily for sweet potatoes than for silage, indicating that slightly more than 250 pounds of silage were required to equal 100 pounds of sweet potatoes. Butter churned from the first two tests showed higher color for the period of sweet potato feeding than for silage feeding. There were no noticeable ill effects on flavor of milk and butter or health of cows due to feeding sweet potatoes. When the grazing value of sweet vines (under investigation) is included, sweet potatoes are not only satisfactory, but are also economical as a dairy feed on many small farms.

P41. Soy Bean Hay as the Sole Roughage for Dairy Cows. L. F. HERRMAN AND G. A. BOWLING, West Virginia University.

Two trials were conducted to determine if soy bean hay as the sole roughage in the ration is as efficient as soy bean hay and corn silage. The single reversal method was used, and the length of the periods was forty-five days in one trial, and thirty in the other. Ten cows were used in one trial, twelve in the other. The check ration contained a grain mixture of corn, oats, wheat bran and cottonseed meal, while the trial ration for the first trial contained a grain mixture of corn, oats and wheat bran, and in the second trial a grain mixture of corn and oats only. The rations supplied approximately equal amounts protein and total digestible nutrients.

The average daily milk production during both trials was 30.7 pounds of 4 per cent milk per day per cow when the check ration was fed, and 30.5

pounds per day when the soy bean hay was the sole roughage. The difference in loss or gain in weight on the two rations was not significant.

P42. Limited Grain Feeding of Dairy Cattle. C. E. WYLIE AND L. R. NEEL, University of Tennessee.

This experiment was started in February, 1933, and is still in progress at the Middle Tennessee Experiment Station, Columbia, Tennessee. There are two groups, of seven cows each, of registered Jerseys which are fed rations as follows:

Group I. (Full grain)

Alfalfa hay ad libitum
Corn silage, 3 lbs. per 100 lbs. liveweight
Concentrates, 1 lb. to 3 lbs. milk
Pasture* April to October inclusive

Group II. (Half grain)

Alfalfa hay ad libitum
Corn silage, 3 lbs. per 100 lbs. liveweight
Concentrates, 1 lb. to 6 lbs. milk
Pasture* winter and summer (weather permitting)

The results to December 31, 1935, show the following.

- I. The half grain group not only consumed considerably less concentrates but also less hay and silage than the full grain group.
- II. The full grain group produced more milk and butterfat than the half grain group.
- III. The feed cost per pound of butterfat and per hundred pounds of milk was lower on the half grain group.
- IV. The income over cost of feed was approximately the same for each group, with the half grain group slightly greater.
- V. The half grain group were on pasture 1015 days while the full grain group were on pasture 610 days during the total time of 1048 days.
- VI. The type of farming for the two groups is significantly different.

P43. The Value of Grinding Grains for Lactating Dairy Cattle. A. L. DARNELL, Texas A. & M. College, AND O. C. COPELAND, Texas Agricultural Experiment Station.

Experiments are reported concerning the value of grinding grains for dairy cows. Comparisons were made on whole vs. ground milo, whole vs. ground oats, whole vs. ground barley and whole vs. ground corn.

* Pasture included bluegrass, lespedeza, and Sudan grass in midsummer. The remainder of the year it included barley and rye in addition to bluegrass.

In all of the experiments there was a greater production of milk during the periods of ground grain feeding which was accompanied by a greater consumption of concentrates. In the experiments with corn and oats the increased milk production during the periods of ground grain feeding could be accounted for by the greater consumption of concentrates, and there was only a slight difference between whole and ground milo which could be attributed to grinding. However, with barley there was a very significant difference favoring grinding. Increased milk production favoring grinding was much greater with high producing cows than with medium or low producers. More small grain such as milo will pass through the cow unmasticated than the larger grains such as corn. Very little nutriment was removed from any of the whole grains passing through the cow's digestive system.

P44. The Feed Value of Oat Mill Feed as a Hay Substitute for Dairy Cows. A. W. LATHROP AND G. BOHSTEDT, Wisconsin Experiment Station.

The experimental results given in this summary were obtained from feeding trials with dairy cows at Monona Farm, the livestock feed research farm of the Quaker Oats Company, where the feeding experiments with oat mill feed were under the direction and supervision of the Wisconsin Agricultural Experiment Station.

Oat mill feed is a by-product of the manufacture of oat meal. It is a finely ground mixture of about 85 per cent oat hulls and 15 per cent oat shorts and oat middlings. Seventy-one samples of oat mill feed, taken over a period of as many months, gave an average composition of $5.5 \pm .08$ (c) per cent crude protein, $27.9 \pm .12$ per cent crude fiber, 1.7 per cent fat, and 6.4 per cent ash. Some of the more important ash constituents and their amounts contained in oat mill feed are: Silicon 2.43 per cent, calcium 0.069 per cent, and phosphorus 0.148 per cent.

A large number of feeding experiments with oat mill feed have been completed during the last nine years but only those in which oat mill feed was compared with timothy and alfalfa hay for lactating dairy cows are considered here.

Oat mill feed was compared in double reversal feeding trials, and in hay, silage, and suitable concentrate rations: With timothy hay in three trials; with alfalfa hay in two trials; and with alfalfa hay, 50 per cent replaced, in three trials.

Weight changes in comparable lots were about the same, and calculated on a feed replacement basis for the production of standardized milk, oat mill feed was worth about 95 per cent as much as U. S. No. 1 timothy hay and fully 70 per cent as much as uniformly high quality alfalfa hay in

these short time double reversal experiments lasting 147 days. In the cases of growing animals, longer feeding periods, and otherwise less favorably constituted rations, a lower value would be expected. This is simply in recognition of the minerals, vitamins, and superior proteins of high quality hay.

P45. Milk and Butterfat Yields of Holstein Cows on Rations Restricted to Roughage. J. R. DAWSON AND R. R. GRAVES, Bureau of Dairy Industry, U. S. D. A.

For several years the Bureau of Dairy Industry of the United States Department of Agriculture has conducted experiments at their field stations on various phases of improving roughages for dairy cattle feeding. The purpose of one important phase of these experiments has been to determine the level of milk and butterfat production that can be expected from cows when their rations are restricted entirely to high quality roughages for entire lactations. No grain is fed. To date 46 Holstein cows of more than average producing ability have completed 62 lactation period records when fed rations restricted to different roughages, according to the following groups:

Group 1. Twenty-three cows made 29 records when fed alfalfa hay and corn silage ad libitum and pasture.

Group 2. Fifteen cows made 24 records when fed only alfalfa hay of good quality.

Group 3. Four cows made 5 records when fed pasture grass hay which was cut at an early stage of maturity.

Group 4. Four cows made 4 records when fed only silage made from pasture grass cut at an early stage of maturity.

The 46 cows also made records under full feed conditions whereby they received alfalfa hay, silage, and pasture, and a grain mixture was fed at the approximate rate of 1 pound of grain to each 3 pounds of milk produced. Care and management conditions were similar for all groups.

Average milk and butterfat production between the 4 groups on the respective kinds of roughages was remarkably close, as was the comparative production under full feed conditions. The 62 records on roughage alone averaged 11,416 pounds of milk and 405 pounds of butterfat, age corrected. Under full feed conditions the average production (age corrected) was 18,746 pounds of milk containing 654 pounds of butterfat. The average production on roughage alone was 61 per cent in milk and 62 per cent in butterfat of the average production made under full feed conditions. The records made in Group 1 where pasture formed a part of the roughage averaged 7 per cent higher than the records made in the other 3 roughage groups that received no pasture.

Feed and nutrient consumption and other records bearing on a proper interpretation of the data are presented and discussed.

P46. Some Results of Eight Years of Investigation Concerning the Rôle of Roughage in the Diet of Ruminants. S. W. MEAD AND HAROLD GOSS, University of California.

Having shown that the failure to secure normal growth of dairy males reared on a ration devoid of roughage, results principally from a deficiency of vitamin A, a second experiment was conducted to determine the effect of such a ration on lactation and reproduction, in addition to growth.

Three groups of grade Holstein heifers, on experiment at two days of age, were fed, in addition to milk, to 4 months of age, as follows: Group 1, the basal ration consisting of concentrates, NaCl, and cod-liver oil; Group 2, the basal ration, plus calcium carbonate; and Group 3, the basal ration plus calcium carbonate and paper pulp. The animals were kept muzzled except when stanchioned for feeding.

There was no difference between the results obtained from any of the groups which could be attributed to the experimental procedure.

Skeletal growth was normal. Increase in body weight and milk production following first calving were subnormal because of insufficient nutrients. Although the appetites of the animals were usually excellent, it was necessary to limit food consumption in an effort to avoid serious bloat. By means of a rumen fistula, made at the time of bloat, gas was collected and found to be principally carbon dioxide, with no detectable amount of methane.

Of the 14 original heifers, 4 died of bloat at the ages of 9 months, 2 years and 6 months, 3 years and 5 months, and 3 years and 8 months; one, of chronic indigestion at 4 years and 2 months; two, of pneumonia complications following posterior paralysis (prior to calving) at 2 years and 3 months; one, of accident at 2 years and 10 months; one, as a result of complications following operative procedure for the formation of a permanent rumen fistula, at 3 years and 4 months; one, at 3 years and 4 months following the removal of a large shoulder tumor. Four are still alive at six years of age.

Reproductive functions have been normal. Four animals have each produced 3 calves; 1 produced 2 calves, and 4 others 1 calf each. Seventeen 293-day lactations have averaged 6,488 pounds of milk testing 3.19. The range in production was from 4,460 to 9,788 pounds of milk, 107 to 357 of butterfat, and 2.16 to 4.58 per cent of fat.

All animals ruminated at irregular intervals.

The efficiency of digestion was found to be similar to that of animals receiving roughage.

With the exception of bloat, due to fermentation with the formation of carbon dioxide, none of the symptoms usually associated with a roughage-free diet was noticed.

The principal limiting factor, when vitamin A had been supplied^{In}, appeared to be the susceptibility to bloat when on full feed.

P47. Spectrophotometric Data Bearing on the Character of the Pigments Obtained in Routine Determinations of Carotene in Hays, Silages, and Freshly Cut Plant Materials. EDWARD A. KANE, HERBERT G. WISEMAN, A. H. HARTMAN, AND C. A. CARY, Bureau of Dairy Industry, U. S. D. A.

Evidence from a number of laboratories has shown that the carotene in the grasses and in the alfalfa and corn plants is almost exclusively β -carotene. This agrees with the spectral absorption curves for the carotene obtained in the routine analyses of these substances in this laboratory; but carotene is readily oxidized and the carotinoids are more or less readily altered by acids, leaf xanthophyll being readily attacked even by organic acids. Intermediate pigments are formed in these decompositions. The oxidation products, according to Kuhn and work done in this laboratory, are largely—if not completely—removed from carotene in the Willstätter and Stoll procedure; but Kuhn and co-workers found that the pigments formed by the action of acids on xanthophyll, resemble it in spectral absorption and adsorptive properties, but differ from xanthophyll in being removed from carotene with greater difficulty in the Willstätter and Stoll procedure.

The spectral absorption curves for carotene fractions obtained here in the routine analysis of alfalfa hay indicate the presence of small amounts of colored material other than β -carotene. It is not α -carotene or unremoved xanthophyll. The quantity present is insufficient to materially reduce the vitamin A potency of these extracts when compared biologically with equivalent amounts of β -carotene measured at wave length 436 m μ . Almost identically the same spectral absorption curves are obtained with carotene extracts from corn silage; but we have not tested their potency biologically. When acid (HCl) alcohol is used in extracting fresh green material, a large portion of the carotene is destroyed, and there is difficulty in separating the pigments.

In a sample of alfalfa silage, which was preserved by the addition of acid, we were unable to determine definitely the amount of carotene because of the presence of a pigment resembling that described by Kuhn as formed by the action of acids on xanthophyll.

P48. Rate of Decomposition of Carotene in Hays During Storage at Different Seasons of the Year. HERBERT G. WISEMAN, EDWARD A. KANE, AND C. A. CARY, Bureau of Dairy Industry, U. S. D. A.

Samples of baled alfalfa hay were stored in a fairly dark unheated barn loft, and their carotene content was determined from time to time to get at the rate of loss of vitamin A potency. During December, January, and

February, when the average outside mean daily temperature was 40° F. or less, the average (11 samples) loss of carotene per month was 2.6% ; for the colder fall and spring months, when the temperature was 40° to 55° F., this loss was 4.4% per month ; whereas during the warmer fall and spring months (average outside mean daily temperature 55° to 70° F.) the loss of carotene (20 samples) was 6.5% per month. During June, July, and August, when the average outside mean daily temperature was 70° F. or higher, the loss of carotene was very much more rapid. Four samples that were stored for the first summer after cutting lost on an average 21.2% ; and four other samples during storage for the second summer lost 11.6% of their carotene content per month.

The percentage rate of loss of carotene in timothy hay during storage under the same conditions is practically the same as that in alfalfa hay.

These figures were obtained with hays that appeared to have been normally "cured" and in which no evidence of "fermentation," or of a "ground" or "swotty odor" was observed.

The percentage loss of carotene during the storage of alfalfa hay under the above conditions is very much greater than the percentage loss of natural green color as determined by the Division of Hay, Feed, and Seed, Bureau of Agricultural Economics, United States Department of Agriculture.

P49. Effect of Moisture Content and Density of Stored Roughage on Temperatures Attained During Storage and the Quality of the Product. J. B. SHEPHERD, T. E. WOODWARD, AND R. R. GRAVES, Bureau of Dairy Industry, U. S. D. A.

Two experiments, one with baled long and shredded stover and one with long and chopped alfalfa hay stored loose, furnish some preliminary data on this subject.

THE CORN STOVER EXPERIMENT

In October and November, 1934, four different lots of corn stover were baled with moisture per cents of 45.7, 39.0, 36.4, and 26.7. Each lot included both long and shredded corn stover and bales of different tightness or density. Each lot was stored separately in a small pile surrounded by baled straw.

At the time of baling, shredded stover bales averaged 7.57, 10.17, and 12.70 pounds and long stover bales 6.08, 8.26, and 10.32 pounds dry matter per cubic foot, respectively, for loose, medium-compact, and tight bales. The maximum temperatures attained did not exceed 68° F. in the loose and medium-compact long stover bales containing 26.7 and 36.4 per cent moisture, in the other bales the maximum temperatures attained ranged from 83.0 to 141.0° F. No bales were free from mold. Mold ranged from traces only in some bales to extra heavy in others.

Temperatures and mold were highest in bales with the highest moisture content and lowest in bales with the lowest moisture content, higher in tight bales than in loose bales, and higher in shredded stover bales than in long stover bales. Temperatures averaged higher, but mold growth averaged slightly less in shredded stover bales than in long stover bales containing the same quantity of dry matter per cubic foot; 26.7 per cent moisture was not low enough to prevent heating and mold.

THE ALFALFA HAY EXPERIMENT

In June, 1935, two different lots of first cutting alfalfa were stored loose in separate compartments in both chopped and long condition. Lot 1 consisted of about 6 tons each of long hay and of hay run through a cutter set to cut in $\frac{1}{4}$ inch lengths. The moisture content of both was 27 per cent. Lot 2 consisted of about 5 tons each of long hay and of hay run through a cutter set to cut in $\frac{3}{4}$ inch lengths. This lot had 25 per cent moisture. After 100 days of storage, a single reversal feeding trial was conducted with Holstein cows.

At the time of storage the finely chopped hay of Lot 1 occupied 152 cubic feet per ton with 9.60 pounds dry matter per cubic foot; the coarsely chopped hay 218 cubic feet with 6.85 pounds; the long hay of both lots 475 cubic feet with 3.06 and 3.14 pounds. Both long and chopped hays heated in storage; finely chopped hay reached 151° F. in 9 days (some spots 190° F.) and after 3 months was still 100° F.; coarsely chopped hay reached 128° F. in 19 days, subsiding to air temperature in 2 months; Lot 1 and 2 long hays reached 122° F. and 120° F. in 4 and 1 days, respectively, both subsiding to air temperature in 3 weeks.

Stored with 27 and 25 per cent moisture, all hays lost considerable carotene during storage, but long hay retained more carotene than chopped hay of the same lot; long hays lost part and chopped hays all of their green color during storage. Coarsely chopped hay was light brown and finely chopped hay brown to black in color. Dry matter losses during storage were small, but greater for chopped than for long hay. In the feeding experiment, black hay (chopped) was less palatable, but brown hay (chopped) fully as palatable as hay with a more normal color (long); cows produced a little less milk and declined faster in milk production on the black or brown hay (chopped).

A lower per cent of moisture than that used in this experiment is necessary to prevent excessive heating and excessive losses of carotene and color in chopped hay.

P50. The Effect of Certain Factors upon the Color and Pigments of Alfalfa Hay in Storage. T. E. WOODWARD, Bureau of Dairy Industry, U. S. D. A.

Hays lose color and pigments from the time they are mowed until they are stored and also from the time they are stored until they are fed. This

investigation has to do with the losses which take place in laboratory samples of alfalfa hay when stored under different conditions for periods of 6 to 9 months.

Data are presented to show the destructive action of diffused sunlight, warm temperatures, lack of ventilation, and high moisture content upon the green color, chlorophyll, and carotene. The effect of presence or absence of air on the color and carotene content of hays with various percentages of moisture is also discussed. Ways in which the results of this study may be applied practically are suggested.

MANUFACTURING SECTION

M1. Results Obtained when the Several Minnesota Reagents Were Employed for Testing Buttermilk. D. F. BREAZEALE AND E. W. BIRD, Iowa State College.

Three Minnesota reagents have been offered to date—a. The original reagent (termed here, Reagent A) (1); b. One described by Sommer (Reagent B) (2), and c. a third sold by Nafis Division of the Kimball Glass Company (Reagent C) (3). Reagent A had been extensively studied at the Iowa station in connection with buttermilk testing. Dr. B. L. Herrington of the N. Y. (Cornell) station called the attention of the authors to the fact that his results with Reagent C were not in conformity with those reported for Reagent A and stated that he had evidence to the effect that saponification might be responsible for the differences between the methods; a greater saponification occurring with Reagent C than with Reagent A. His methods were not disclosed.

Reagent C contains "Castor oil Potassium Hydroxide Soap solution" (3) so that indirect methods of determining saponification were necessary. A single sample of buttermilk was employed and samples were digested 0, 2, 5, 10, 15, 25, 40, and 60 minutes with each reagent. Triplicate determinations were made at each point. The averages of the triplicate determinations were plotted against time. Each graph rose steeply to a maximum (at approximately the 5 minute heating period) and then dropped off. The slope of the curve after the maxima was greatest with Reagent C, least with Reagent A and was intermediate with Reagent B. These curves were extrapolated to zero time and an average of the values was taken as that which would have been obtained had no saponification occurred. From these data it was calculated that approximately 5 per cent saponification occurs with Reagent A, 8.5 per cent with Reagent B, and 16.75 per cent with Reagent C if the maximum test possible with each test (as shown by the graph) was considered.

It was further shown that this saponification accounts for approximately 27 per cent of the total difference between the test with Reagents A and C. The remaining difference results from differences in manipulation of the tests.

The following figures which are each the averages of 12 replicate determinations of the same buttermilk sample illustrate the relationships among several buttermilk testing methods:

Test Used: Minnesota A; Minnesota B; Minnesota C; American Assoc.;
Avg. Value: 0.512 0.465 0.198 0.739

Test Used: Babcock; Mojonnier*
Avg. Value: 0.249 0.745

* Average of duplicates.

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M2. The Effect of Preservatives on the Results Obtained with Ice Cream Mixes by Several Testing Methods. P. H. HOSTETLER, C. A. IVERSON, AND E. W. BIRD, Iowa State College.

The testing methods employed were: Crowe test (1), glacial acetic-sulfuric acid test (2), Mojonnier test (3), Overman-Garrett (4), and Minnesota (5).

The results obtained indicate that:

1. Mercuric chloride, potassium dichromate and formalin will prevent spoilage of ice cream mix samples during 8 days when employed in following amounts—*a.* HgCl_2 —0.1 gm.; *b.* $\text{K}_2\text{Cr}_2\text{O}_7$ —0.1 gm. and *c.* 40 per cent formalin—0.1 cc. per 100 gm. mix.

2. When samples were stored at 37° C. reduction of HgCl_2 and $\text{K}_2\text{Cr}_2\text{O}_7$ was observed.

3. Formalin seemed to harden the proteins and made it difficult to separate the fat by certain testing methods.

4. Mojonnier tests of preserved samples indicate that this method could be used satisfactorily on samples preserved with HgCl_2 , $\text{K}_2\text{Cr}_2\text{O}_7$ or formalin.

5. The Crowe test yielded reasonably precise results with samples preserved with HgCl_2 but not with samples preserved with $\text{K}_2\text{Cr}_2\text{O}_7$ or formalin.

6. The glacial-acetic-sulfuric acid method did not yield reliable results with any of the preservatives.

7. The Minnesota test showed practically no change between the original and the preserved mixes but yielded a result that was too high.

8. The Garrett-Overman test was not affected by HgCl_2 but was changed by $\text{K}_2\text{Cr}_2\text{O}_7$ and formalin. This test, like the Minnesota, was too high.

9. A comparison of the tests on non-preserved mix indicated that —*a.* the glacial-acetic-sulfuric acid test gave results approximating closely those of the Mojonnier; *b.* the Crowe tests were slightly higher than the Mojonnier but were sufficiently precise for practical purposes; *c.* the Minnesota and Overman-Garrett tests if used as prescribed yielded results that were too high for practical purposes, and *d.* the Minnesota test used with "reader-oil" was still too high, while when used in this fashion the Garrett-Overman checked the Mojonnier value more closely than any other of the centrifugal tests studied.

CONCLUSIONS

1. No comparative study of testing methods involving centrifugal tests for fat in ice cream mix should be conducted with preserved samples.
2. Ice cream mixes containing preservatives should be tested by the Mojonnier method if precise results are desired.

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M3. The Determination of Citric Acid in Milk. HUGH L. TEMPLETON,
University of Wisconsin.

The amount of citric acid present in milk or cream may play a very important role in the behavior of manufactured products. Thus it would seem that any method which could be used for the rapid determination of citric acid in milk might serve a very useful purpose in the control of manufacturing processes. Examples of the use and importance of the citric acid in milk are numerous, and one might cite the effect of the addition of certain salts, such as sodium citrate, on the stability of milk for concentration and the relation between the citric acid content of the cream and the flavor and aroma of the butter made from it, since it has been shown that the proportions of these aromatic constituents depend upon the amount of citric acid present.

The methods commonly recommended for the gravimetric determination of citric acid in milk indicate that it is advisable to allow the pentabromacetone precipitate to stand overnight before filtration and then a solubility correction must be made in the calculations. Titration methods have been used by a number of investigators, but most of these have the objection that there are a number of steps in which some of the material may be lost.

This paper presents a study of a number of methods that have been suggested for other materials containing citric acid with modifications designed to meet the conditions existing in milk. Various methods suggested for the determination of citric acid in milk have also been utilized and modified in an effort to reduce the time factor. A volumetric method has been used in which pentabromacetone is formed and extracted with

ether thereby eliminating the correction for solubility. The pentabromacetone decomposes rather readily in ether solution and advantage is taken of this fact to have the bromine that is liberated react with potassium iodide. The liberated iodine is titrated with standard triosulfate solution and the citric acid equivalent is calculated from the results obtained. The ether extract may be evaporated to dryness and the citric acid calculated from the weight of pentabromacetone obtained. This latter method is quite satisfactory if certain precautions are observed and duplicate analyses may be completed within two hours. While the recovery of citric acid is not absolutely quantitative, this method seems to offer a basis for the rapid detection of rather small differences in the citric acid content of milk.

A colorimetric method has also been developed based on the color formation occurring between citric acid acetic anhydride and pyridine. This method has been found to be quite effective in the detection of very minute additions of citric acid to a given sample of milk.

M4. Vitamin C Content of Milk. C. H. WHITNAH AND W. H. RIDDELL, Kansas Agricultural College.

Milk from 40 to 58 cows was tested chemically for vitamin C for three consecutive days in each of the months from October to April. The cows received during this period a ration consisting of alfalfa hay, silage, and a grain mixture. The Ayrshire, Guernsey, Holstein and Jersey breeds were represented by about equal numbers of cows.

The average vitamin C content of milk from all breeds and for all months studied was 25.5 milligrams per liter. Milk produced during the severe weather of January and February with cows in barn contained less vitamin C than milk from either earlier or later months. Daily changes were often large but if large they quickly reversed the direction of change. The only consistent difference found between breeds was that Jerseys were high. This difference was largely due to genetically related cows. The differences between individuals within a breed were much greater than any differences between breeds. The high cow for each month and breed averaged 159 per cent of the low cow. No consistent relation between vitamin C concentration and yield of milk was found. An average increase of 10 per cent in vitamin C concentration was found from the first to second month of lactation. Later changes in stage of lactation were of only minor importance.

For three cows the regular herd ration was replaced by 30 to 40 kilos per day of green rye plus grain. This grass contained about 0.3 mg. per gram of vitamin C. The vitamin C content of the blood of one cow doubled within two hours and remained high between 12 and 24 hours.

Continued grass feeding did not maintain this high blood level nor cause a similar change in the other cows. Within 48 hours after grass was fed the average excretion of vitamin C in urine had increased about five fold. The vitamin C content of the milk had not changed appreciably within 60 hours after grass was first fed.

M5. Vitamin C Content of Dairy Orange Beverages. M. J. MACK, C. R. FELLERS, W. A. MACLINN, AND D. A. BEAN, Massachusetts State College.

A recent development in the dairy business is the successful sale of bottled orange drinks as an adjunct to the distribution of fluid milk. Several articles have appeared in the literature dealing with the handling and sale of these beverages. Many state and city boards of health have passed regulations governing the composition and processing of dairy orange drinks. The vitamin C content is undoubtedly of more significance than any other property and is the principal dietary essential in orange drinks. This study was carried out in order to furnish some much needed information as to the vitamin C content of dairy orange beverages.

The vitamin C content of three dairy orange beverages was obtained by the biological assay method. Twelve samples of ten different dairy orange beverages were examined for ascorbic acid (vitamin C) content by the new chemical procedure of Bessey and King (use of fresh 2, 6-dichlorophenolindophenol indicator) and by the iodine titration method of Reynolds and Stevens. The loss of vitamin C during storage of the beverages was also determined by the two chemical methods just mentioned.

The results showed that there is good agreement between the biological assay method on the one hand and the dye and iodine methods on the other for the determination of vitamin C (ascorbic acid) in orange beverages. Of the two chemical methods used, iodine titration gave more constant and easily reproducible results than the dye method.

Ascorbic acid values of from 0.003 to .093 mg. per gram, corresponding to from 0.2 to 53 units of vitamin C per ounce were found for the different orange beverages examined. For comparison fresh orange juice contained 228-258 units and canned orange juice slightly over 200 units per ounce. The work also showed that reconstituted dairy orange beverages gradually lose their vitamin C content during cold storage at 40° F. This loss is as much as 15 per cent per day.

The study reveals that while dairy orange beverages are fair antiscorbutics, they contain on the average only 10 per cent as much vitamin C as fresh orange juice. Many dairy orange beverages cannot be considered satisfactory substitutes for fresh or canned orange juice as carriers of vitamin C.

M6. Catalytic Destruction of Vitamins by Manganese During the Pasteurization Process. A. D. PRATT, Virginia Agricultural Experiment Station.

In lieu of manganese pasteurizing vessels milk was pasteurized in glass after addition of manganese lactate equivalent to 9 p.p.m. Feeding of this milk to small animals on appropriate basal diets in contrast with similar groups receiving plain pasteurized milk proved an increased destruction of vitamins B₁ and C, but no destruction of vitamin A.

M7. X-ray Diffraction Studies of Cheese Protein During the Ripening of Cheddar Cheese. S. L. TUCKEY, H. A. RUEHE, AND G. L. CLARK, University of Illinois.

An attempt has been made to identify, by means of X-ray analysis, some of the hydrolytic products formed during the ripening of cheddar cheese. The cheese is usually required to age one to two weeks before the diffraction pattern changes from the ordinary pattern with two halos, which is typical of proteins with peptide linkages, to a pattern with sharply defined rings, characteristic of long-chained organic compounds with staggered arrangement.

X-ray diffraction patterns of 20 amino acids were made and the spacings calculated. It was found that the following amino acids gave diffraction interferences of the same order of magnitude as the cheese samples, hence could contribute to the intensity of the diffraction lines of the cheese patterns.

<i>Spacings in Angström Units Calculated from cheese patterns</i>	<i>Amino Acids</i>
7.57	Histidine, aspartic acid
4.60	Iso leucine, arginine, methionine and hydroxy- proline
4.23	Valine, methionine, histidine, proline, and hydroxyproline
2.92	Iso leucine, proline, hydroxyproline, histidine and serine
2.60	Valine, iso leucine, aspartic acid, proline, hydroxyproline, arginine and norleucine

Crystalline amino acids can be obtained from cheese by extraction with hydrated n-butyl alcohol followed by the evaporation of the alcohol under reduced pressure. The amount of crystalline extract increases with the age

of the cheese. However, traces of it can be obtained when the cheese is but 24 hours old. The hydrated n-butyl alcohol readily extracts the mono-amino, monocarboxylic acids, but upon continued extraction small amounts of diamino and dicarboxylic acids are also extracted. Changes in the liberation of the amino acids in the cheese can thus be followed by comparing x-ray diffraction patterns of the crystalline n-butyl alcohol extract, with standard patterns of the amino acids.

M8. The Relation of the Oxidation-Reduction Potential of Milk to Oxidized Flavor. R. E. WEBB AND J. L. HILEMAN, Dairymens League Laboratories.

The development of oxidized flavors in milk by the addition of copper is due to the raising of the oxidation-reduction potential of the milk to a point sufficiently high to bring about a change in some milk constituent.

Summer milk is able to resist the development of oxidized flavors even in the presence of a high oxidation-reduction potential.

The decreased susceptibility of summer milk to oxidized flavor development does not appear to be due to bacteria.

It seems probable that mixed milk from a large number of herds will rarely develop oxidized flavor unless it is contaminated with copper or some other agent that will raise the oxidation-reduction potential.

There is no relationship between oxidized flavors and oxidation-reduction potentials in the milk of individual cows. Oxidized flavors in such samples can develop when the oxidation-reduction potential is very low.

Since the evidence in the literature seems to indicate that oxidized flavor in milk from individual cows is due to oleinase, the data presented here indicates that the mechanism of oxidation catalysis by oleinase is entirely different from the mechanism of the catalysis by copper, since the former does not involve high oxidation-reduction potentials, while the latter does.

Oxidation-reduction potential measurements afford a very delicate means of determining the source of copper contamination in a milk plant.

An improved electrode for the measurement of oxidation-reduction potentials is described.

M9. Some Observations on the Electrokinetic Potential of Milk Fat. E. L. JACK AND C. D. DAHLE, Pennsylvania State College.

The electrophoretic method was used to study the effect of various agents upon the electrokinetic potential and to determine what substances are responsible for the potential. The results obtained are as follows:

1. The potential is negative in normal milk and is influenced by the addition of electrolytes. Additions of anions in concentrations of multiples of 10^{-2} N decreased the negative potential with increasing valence and tri- and tetra-valent anions reversed the sign. Similar additions of cations increased the negative potential with increasing valence.

2. The isoelectric point of the fat globules is found to be pH 4.3.

3. Heating the milk had no effect on the electrophoretic mobility until pasteurization temperatures are reached and above this the mobility increased with increasing temperatures. There was a progressive destruction of creaming above the pasteurization temperature. However, where the skim milk was heated above the pasteurization point and fresh cream added the creaming was destroyed the same as where the whole milk was heated but the mobility of the fat globules was not affected.

4. The lipid phosphorus content of the cream per unit of fat decreased with increases in temperature above the pasteurization temperature.

5. There was no deviation from normal mobility due to single stage homogenization with accompanying clumping of the fat globules, or to double stage homogenization which produced no clumping. There was no difference in mobility between individual globules of one micron diameter or clumps of 20 microns diameter.

6. In creams of different fat percentages the mobility increased proportionately with the fat contents from 60% to 81% fat. Up to 60% there was no change in mobility. The lipid phosphorus content per unit of fat decreased between 60% and 81% fat content.

7. The isoelectric point of butter oil emulsified in distilled water was found to be pH 3.2. When the butter oil was emulsified in 3% casein sol the isoelectric point was pH 4.7. When the emulsifying medium was a milk phospholipid sol the isoelectric point was pH 2.0.

8. A synthetic milk made by emulsifying butter oil in a casein sol and then adding phospholipid, lactose and milk salts gave a pH / mobility curve dissimilar to that for fat globules from normal milk with the isoelectric point of the fat globules at pH 4.6. A similar milk made by emulsifying the butter oil in the phospholipid sol, and then adding the casein, milk salts, and lactose resulted in a pH / mobility curve similar to that for normal milk with an isoelectric point of pH 4.3.

9. When increasing amounts of phospholipid solution were added to butter oil emulsified in distilled water the mobility changed until an amount equivalent to about 16 mgm. lipid phosphorus per 100 gms. fat had been added. Further additions had no effect on the mobility. The addition of increasing amounts of casein sol to the above system containing 16 mgm. lipid phosphorus per 100 gms. fat resulted in a change in mobility until the equivalent of 0.4 gm. of casein nitrogen per 100 gms. fat was added. Further additions of casein sol were without effect. These values for lipid phosphorus and protein nitrogen correspond to those of 60% cream.

The above results seem to the authors to indicate that the electric potential is not responsible for the heat destruction of creaming in milk, nor for the clumping of fat globules in homogenization. The data indicate that the inner layer of the fat globule membrane is phospholipid and that the outer

surface is composed chiefly of protein. The values found by analysis and synthetic studies suggest that 60–65% cream is composed of the fat globule plus its entire absorbed membrane.

M10. A New Type of Quinhydrone Electrode for Directly Determining the Hydrogen-ion Concentration of Cheese and Other Materials. GEORGE P. SANDERS AND EARLE O. WHITTIER, Bureau of Dairy Industry, U. S. D. A.

The use of various modifications of the quinhydrone electrode for following changes in H-ion concentration in cheese was studied. The most satisfactory type of electrode is described below. By direct measurement of pH in the cheese itself rather than in a plug sample, a shorter time is required to carry out the determination, and much of the damage to the cheese due to plugging is obviated.

A 22 or 20-gage gold-plated platinum wire 6 inches long is used as the electrode. It is inserted into a capillary glass tube 4 inches long, 0.09 inches inside diameter, and 0.127 inches outside diameter. The tube or sleeve is flamed to about 0.030 inches in diameter at the tip or lower end and a cup-shaped enlargement 0.35 inches in diameter is blown in the upper end. The same sleeve is used in measurements on either liquids or semi-plastic solids.

The quinhydrone is applied by either or both of two methods, as follows: (1) One end of the electrode is dipped several times in a saturated solution of quinhydrone in acetone and allowed to dry after each dipping; (2) quinhydrone is inserted into the cup-shaped enlargement at the upper end of the sleeve and pushed down into the sleeve by means of the wire electrode.

The determination of pH is carried out as follows: (1) In cheese or other semi-plastic materials, the electrode with quinhydrone is inserted to a depth of 3 inches into the cheese and the sleeve is then withdrawn a distance of 1 inch while the electrode is held in a fixed position so that the quinhydrone-coated wire extends a distance of 1 inch past the sleeve at a position 3 inches within the cheese. The tip of the KCl tube of a calomel half-cell is placed in contact with the surface of the cheese, the usual connections are made, and the voltage is determined with a potentiometer. The use of this apparatus and this procedure makes it possible to insert a sufficient amount of quinhydrone with the electrode, and prevents the quinhydrone from being wiped off during the insertion. The small size of the hole causes only a minimum of damage to the cheese.

The correction for temperature, when the temperature of the cheese is higher than that of the calomel cell, is made by adding 0.00074 volts to the E.M.F. reading. The direct readings in cheese, after adding the temperature correction, were found to be low, the average decrease being -0.004 volts.

(2) In liquids, the sleeve is thoroughly rinsed with the liquid by suction, the electrode with quinhydrone is inserted into the sleeve, and the sample is

drawn in by holding the tip of the sleeve in the sample and moving the electrode up and down. Capillary action causes the sample to rise about 1 inch in the tube. The voltage is then determined in the usual manner.

A small calomel cell contained in a calcium chloride drying tube has been designed for use with the apparatus; a small L. & N. portable potentiometer has been found satisfactory for field work or factory determinations.

The results of many determinations show that the method as described is accurate and is particularly suitable for factory control operations.

M11. An Improved Motor Driven Curd Tester. LESLIE A. CHAMBERS,
University of Pennsylvania.

A new type of motor driven curd tester is described and will be demonstrated. The motor drive is so arranged that the complete test operation is completed in less than one minute, at the end of which time the knife is in position for the next test. Many causes of error in the usual methods of curd measurement have been eliminated. A comparative study reveals that when measurements are made at the rate of 60 per hour the deviation of individual measurements from the mean is reduced by more than one half when the new tester is used. Simplicity and automaticity make possible satisfactory duplication of results obtained by different operators.

M12. Use of a Dynamic Foam Meter for Measuring Foaming Ability of Ice Cream Mixes. J. L. MINKIN AND J. H. ERB, Ohio State University.

A dynamic foam meter such as used for studying thickness of the foam layer and film stability of boiler water was thought to have possibility as an instrument, which would show film stability of milk products and ice cream mixes. The apparatus is called a dynamic foam meter because the observations are made while the formation of bubbles and foam is going on. It is an arrangement for blowing air through a porous disc, made of alundum, into a column of liquid. Constant pressure is maintained. In boiler waters the height of the foam layer was found to be proportional to the stability of the films.

Since milk and ice cream mixes are more complex products than boiler waters, it was necessary to set standards of procedure for running these products in the foam meter. The first experiments were conducted with simple mixtures of various products going into ice cream mixes. The results with these mixtures in the foam meter correlated with their whipping ability in an ice cream freezer. Experiments have also been made with ice cream mixes. It has been found that film stability of a mix, as measured by the foam meter, and the whipping ability of the same mix in the freezer can be correlated in a general way. With more quantitative

studies it is hoped that this instrument may suggest a plan of attack for studying potential whipping ability of ice cream mixes.

M13. Milk Inspection Work in the United States. THOMAS B. HARRISON, University of Tennessee.

A questionnaire was mailed to 212 cities in the United States requesting information by a series of questions. Replies were received from 167 cities with a total population of 29,062,750.

Most of the cities had ordinances and 45 per cent had adopted the standard milk ordinance of the U. S. Public Health Service. The inspectors were appointed chiefly through civil service, by the Health Officer, or by the Mayor. About one-half of the cities required a High School education and one-third a college education to be an inspector.

The methods of analysis employed by the various cities, expressed as percentages of the cities replying, were plate count 97.5, sediment 75.7, lactometer 71.5, methylene blue 38.8, direct microscopic 33.8, and cryoscope 15.7.

M14. A Study of the Abnormal Relationship of Fat to Solids-not-Fat in Milk. H. C. MOORE AND K. S. MORROW, University of New Hampshire.

This is a progress report on work being conducted in an attempt to determine the causes of abnormal relationship of fat to solids-not-fat found in the milk coming from some of our New Hampshire dairy farms.

During the past year the fifteen day composite samples on 40 herds delivering milk to a milk plant in the State were tested for fat and total solids, the latter by the Mojonnier method. This group of producers all represent rather large herds so as to eliminate the individual cow factor as much as possible. The per cent fat for the 24 periods varied from 3.43 to 3.85 and averaged 3.68. The per cent solids-not-fat varied from 8.41 to 8.85 and averaged 8.64, the total variations on fat being 0.42 per cent and on solids-not-fat 0.44 per cent; showing that the solids-not-fat varied more than the fat. When the same comparison is made on several individual herds, the solids-not-fat varied as much as 1.2 per cent during the year while the per cent fat varied only 0.8 per cent.

In the relationship of fat to solids-not-fat in the milk these farms can be divided into three groups, namely—first, those producing milk with normal relationship between fat and solids-not-fat; secondly, those producing milk with a solids-not-fat content abnormally low for the fat content; and thirdly, those producing milk with a solids-not-fat content that is both abnormally high and abnormally low for the fat content. Only a very few farms showed a consistently high relationship of fat to solids-not-fat for the entire period studied.

In addition to the above data, monthly tests have been made on 3-day composite samples from individual cows in the University dairy herd. The average fat test for the same period was 3.87 per cent; solids-not-fat, 8.83 per cent. The relation of fat to solids-not-fat was consistently above the normal.

A few salients on this investigation to date are:

1. That the solids-not-fat content of the milk from these farms showed greater variations in general than the fat.
2. That the solids-not-fat content is higher in the milk during the time of year when pastures are good.
3. That the solids-not-fat content drops when pastures become short and when the cows are put on barn feeding.
4. That at certain seasons of the year the solids-not-fat content decreases when the fat is increasing.

The continuation of this investigation includes the securing of monthly individual cow samples and a study of the farm and herd management practices.

M15. Quality-Composition Relationships in Goat's Milk. J. C. MARQUARDT, New York Agricultural Experiment Station, Geneva.

It was undertaken to establish the accuracy of determining mean values for the composition of milk based upon samples collected over a wide area at a specified time. Goat's milk samples collected at this station had previously been used to calculate the mean values for goat's milk composition based upon the values collected in one locality over a long period of time. The study has revealed the reliability of the new method of obtaining mean values.

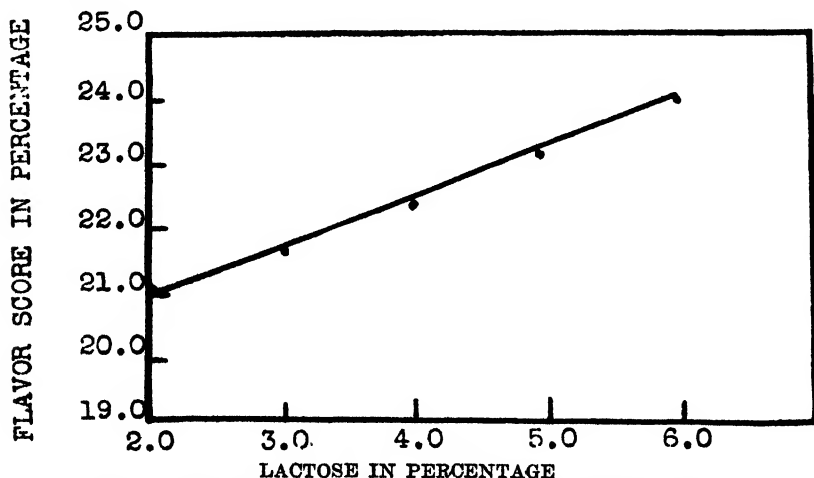


Fig. 1. Relationship of lactose content to the flavor of goat's milk.

This study was started in 1933. Since that time significant data have been collected regarding lactose-salt and quality relationships. High lactose and low salt are associated with quality in goat's milk. Variations in fat, curd tension, and total solids within a liberal range did not affect the quality of the milk. Fat globule size and like matters have been studied.

This project while supplying dairy scientists with organized data has aided goat breeders in improving the quality of their milk in all parts of the country.

The scope of this work is best appreciated by the fact that more than 150 scientists in all parts of the United States assist with the work.

The two figures show the quality relationship to lactose and salt content.

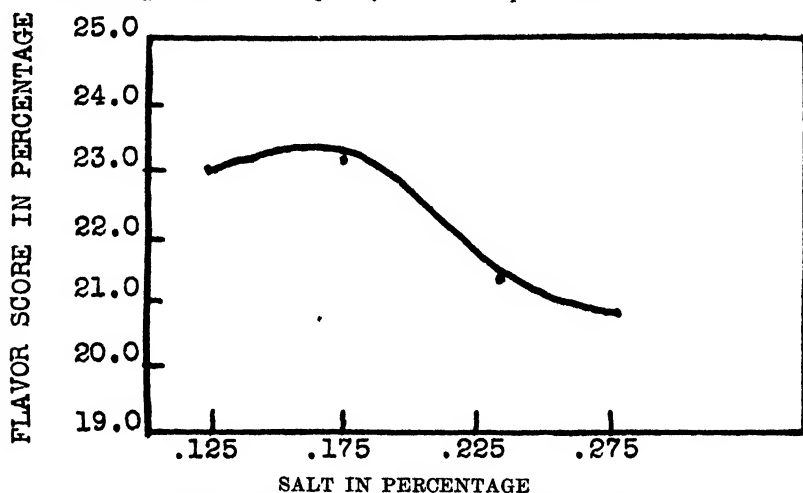


FIG. 2. Relationship of the salt content to the quality of goat's milk.

M16. Observations on the Development of Rancidity in Sweet Milk, Cream and Butter. E. L. FOUTS AND EARL WEAVER, Oklahoma A. and M. College.

For the past several years letters from farmers in the state have indicated that there has been a rather high incidence of the flavor defect in milk, cream and farm butter commonly known as rancidity.

This flavor defect had not been observed in milk from the college herd until in 1932 when an experiment was begun which involved the scoring of milk from individual cows at regular intervals. Rancid flavor has been observed with alarming regularity in milk from as many as three to five cows in an experiment involving twelve to twenty animals over a 140-week period. These observations revealed that rancidity while most likely to occur near the end of the lactation period may occur at most any time

within the milking period. It is the least noticeable during the spring and summer months when the cows are on pasture. In scoring the milks from these cows which scoring included over 5,000 observations, 10.4 per cent of the criticisms indicated some degree of rancidity.

Single milkings from these individual cows were separated and the cream standardized to 35 per cent fat with skim milk from the same lot of milk. The cream was cooled to 45° F. and held at that temperature for 15 hours, after which it was churned in a multiple churn capable of handling six different lots of cream under identical conditions. Milkings from 3 cows of the same breed in a similar stage of lactation were used as checks.

The rancid samples required from 10 per cent to 500 per cent longer to churn than the normal samples. There were no significant differences in the per cent fat in the buttermilk from the rancid cream and the buttermilk from the normal cream. Likewise there were no differences between the tests of the skim milk from the rancid and normal milks. The cream from the rancid samples increased in rancidity while the skim milk was off-flavored but was not rancid. The butter from the rancid cream became rancid with great rapidity and the butter from the normal samples frequently also became rancid. Pasteurization of the milk or cream (145° F. for 30 minutes) soon after milking prevented the off-flavor from developing.

Microscopic observation and measurements revealed very little difference in the size, shape or number of fat globules between the normal and rancid samples of milk. Only in samples of extremely rancid milk could an increased amount of lipolytic activity be detected. Considering the results of these trials it is thought that the decreased size of fat globules near the end of the lactation period is not a very significant factor in the development of rancidity and prolonged churning.

M17. Concerning the Cause of Rancid and Oxidized Flavors of Bovine Origin. J. A. ANDERSON, Bureau of Biological Research, Rutgers University, J. G. HARDENBERGH, AND L. T. WILSON, Walter-Gordon Laboratory Co., Inc., Plainsboro, N. J.

Information acquired over a period of several years suggested that the development of off-flavors in raw milk might be due to the feeding of rations in which certain labile accessory food factors had been greatly diminished by improper curing or by storage. Careful observations during the autumn, winter and spring of 1934-35 on two large farms producing low count milk, one of which had a high and the other a low incidence of individual cows producing off-flavored milks further supported the thought that off-flavors might be caused by dietary deficiencies. Feeding experiments have thus far substantiated this idea.

The more important results obtained thus far may be summarized as follows: Artificially dried alfalfa hay appeared to be richer in the factor, or factors, preventing rancidity in milk than field cured hay of good quality. The temperature at which the alfalfa was dried indicated that the factor sought possessed considerable thermostability. Carrots were very much more potent than the artificially dried alfalfa. Oxidized flavors as well as rancid flavors were eliminated by the addition of carrots to the ration. Milk of good flavor was produced for some days after removal of carrots from the diet, demonstrating storage of the necessary factor in the animal. The time elapsing between enrichment of the diet and elimination of off-flavor was such as to indicate we were dealing with an accessory food factor deficiency. Vitamin A in the form of a cod liver oil concentrate added to the ration of a cow producing very rancid milk resulted in considerable improvement but did not entirely eliminate rancidity in all samples. The results with vitamin A suggested that milk of consistently good flavor could have been produced had the experiment been continued a little longer or the amount of vitamin A increased. The addition of approximately eight pounds of carrots to the daily ration was far more effective than the addition of 500,000 U. S. P. units of vitamin A.

The results of these experiments and all available data concerning feeds strongly suggest a relation between carotene content and ability to produce milk of good flavor. In this connection we wish to call attention to the manner in which seasonal variations in the carotene content of feeds result in variations in carotene and vitamin A content of the milk, and that most off-flavor trouble is experienced when pastures dry or cows are fed winter rations. Furthermore the known chemical and physical characteristics of the substance, or substances, necessary for the production of milk of good flavor are outstanding characteristics of carotene. The information gained from these experiments indicates that carotene alone or with associated compounds is concerned with the prevention of rancid and oxidized flavors in raw milk.

M18. Study of the Causes of Bitter Flavor in Cream. LOUIS J. MANUS
AND L. M. THURSTON, West Virginia University.

Certain bacteria, which were isolated from bitter cream, were found capable of causing the production of extremely bitter flavors when cultured in sterile, sweet cream and incubated at relatively low temperatures for a few days. The fact that practically all of the bitter cream shipped to centralizer creameries is received during the winter, when cream storage temperatures on the farms are low, leaves little doubt that some of the bitterness observed is caused by organisms of the types isolated. Two of the cultures of spore forming rods proteolyzed milk rapidly and produced an alkaline reaction. The third culture of spore forming rods curdled the milk with a

strong acid reaction, with possible slow, subsequent proteolytic action. The above cultures yielded negative tests for lipolytic activity. Accordingly, the bitter principal produced by them is believed to be a by-product resulting from protein decomposition.

Two cultures of coccus form, which produced a suggestion of bitterness, were lipolytically active, but produced no proteolysis. It is believed that the suggestion of bitterness they caused in cream was due to the lipase produced by them.

Fifty samples of bitter cream, treated with formalin to prevent bacterial growth, were found to contain lipase in quantities great enough to cause an appreciable increase in acidity. However, the creams did not produce rancidity, showing that either the lipase was inhibited by acid production or it produced other off flavors.

The high bacterial count of the bitter creams studies and the relatively large numbers of the proteolytic and lipolytic types is strong circumstantial evidence that at least part of the bitterness occurring naturally in cream is due to microorganisms. The cream is held at the farms so long previous to shipment as to favor the growth of the undesirable organisms, and because the production of bitter cream occurs almost entirely during the winter season of the year, bacterial action producing either proteolytic or lipolytic fermentation is indicated as the most frequent cause of bitterness. There is little doubt, however, that the secretion of lipase in milk by the cow is the cause for bitterness in some cream.

M19. The Activatability of Milk With Ultra-Violet Light. W. E. KRAUSS, R. M. BETHKE, AND R. G. WASHBURN, Ohio Experiment Station, Wooster.

Information was obtained as to the extent to which certain factors might affect the ultimate vitamin D potency of milk subjected to the same conditions of irradiation with ultra-violet light. Fat percentage, breed, and feed were the variable factors.

After preparing or collecting the samples these were subjected to ultra-violet irradiation from a carbon arc lamp burning industrial C carbons. The distance of the milk film from the source of light, the thickness of the milk film, and the amperage output were the same for the milks to be compared. After irradiation some of the samples were preserved with formalin and stored in a refrigerator until fed; others were dried and stored until fed. Comparative vitamin D potencies were determined according to the usual line test procedure.

Effect of fat percentage. In general, as the fat percentage increased the activatability increased.

Effect of feed. Dry feeding *vs.* pasture feeding—Unirradiated and irradiated pasture milks were more potent than comparable unirradiated and irradiated winter milks.

High protein feeding *vs.* low protein feeding—Milk from cows fed an extremely low protein ration had less initial potency and less potency after irradiation than did milk from cows fed an extremely high protein ration.

A. I. V. silage *vs.* alfalfa hay—Milk from cows fed A. I. V. silage as the sole roughage was less potent before and after irradiation than milk from cows fed alfalfa hay as the only roughage.

It seems that when the fat percentage is approximately constant the chief factor determining the vitamin D potency of milks irradiated under comparable conditions is the original potency of the unirradiated milks.

Effect of Breed. Irradiated and unirradiated Holstein milk standardized to 3.5% fat with Holstein cream and Holstein skimmilk had the same vitamin D potency as irradiated and unirradiated Jersey milk standardized to 3.5% fat with Jersey cream and Jersey skimmilk. When no adjustment for fat percentage was made unirradiated Jersey milk (5.3% fat) had greater vitamin D potency than unirradiated Holstein milk (3.2% fat). After subjecting these milks to the same conditions of irradiation, however, both assumed the same vitamin D potency. This suggests that the solids-not-fat fraction of Holstein milk may contain more activatable material than that of Jersey milk.

M20. The Effect of Feeding Ergosterol to Cows on the Activatability of the Milk. ROBERT F. LIGHT, LOGAN T. WILSON, AND CHARLES N. FREY, Fleischmann Laboratories, New York, and Walker Gordon Laboratories, Plainsboro, New Jersey.

The question has been raised as to whether ergosterol is absorbed through the digestive tract. This was investigated by determining the effect of feeding ergosterol to cows on the amount of vitamin D formed when the milk of the cows is irradiated.

Two groups of cows were fed ergosterol. One group received the ergosterol in the form of dry yeast, and the other group in the form of isolated ergosterol dissolved in oil. Samples of milk from each of these groups and from a control group were exposed to equivalent amounts of ultra-violet irradiation. Butterfats from these irradiated samples were assayed for vitamin D. The samples from both groups of the ergosterol fed cows failed to show any increased potency over the sample from the control group. This indicates that the ergosterol fed to the cows was not transferred to the cows' milk, in amounts detectable by this method.

Following the feeding of the plain ergosterol and dry yeast, the two respective groups of cows were fed irradiated ergosterol in oil and irradiated dry yeast. Butterfat samples of milk from these groups were assayed. The milks in this case were not irradiated. The milk from the irradiated yeast fed group was approximately three times as potent as that from the irradiated ergosterol fed group, although the same number of units of vitamin D was fed to each group of cows.

M21. Treatment of Milk Previous to Separation and the Effect on Viscosity of Market Cream. H. B. HENDERSON AND H. B. ELLENBERGER, University of Vermont.

Trials were carried out to determine the effect of time and temperature factors as related to the processing of milk and cream on the viscosity of market cream. Method of cooling, temperature of cooling, and period of holding milk before separation or delivery to the plant were varied to include combinations of primary practical importance. Particular emphasis was placed on the study of temperature and time factors employed in the various plant processing operations. Temperature treatments for improving the viscosity of cream were also studied.

The instrument used in this investigation for measuring the apparent viscosity of cream was the Borden Body Flow Meter with an efflux of 3.5 m.m. in diameter. This instrument was chosen because of its adaptability to this investigation and because the results expressed as relative viscosity were considered to be at least equally as accurate as those obtained with the MacMichael viscometer, which is used quite extensively in viscosity determinations of milk and cream. Unless otherwise stated all determinations were made on cream testing 35 per cent butterfat at 42° F. The cream after separation at 90° F., or after pasteurization, was cooled to 40° F. by immersion in ice water and aged 24 hours before the viscosity tests here reported were run.

Following is a brief resumé of the results obtained:

Raw cream from milk agitated throughout the cooling process had a higher viscosity than did cream from milk agitated only through the first part of the cooling process, or cooled to 60° F. over a tubular cooler and allowed to cool to 40° F. without agitation, the relative viscosities being 25, 19, and 21, and for the pasteurized cream, 7, 6 and 6.

Raw cream from milk agitated during cooling had a higher average viscosity than did cream from milk not agitated during cooling, the relative viscosities being 20 and 13. The same was true with the pasteurized cream, but the difference in viscosity of the two creams was very small, 7 and 6½.

Raw cream from milk agitated throughout the cooling process had a slightly higher average viscosity than did cream from milk cooled over a tubular cooler at 40° F. or over a tubular cooler to 60° F., the relative viscosities being 27, 24 and 22. This was also true of the pasteurized cream having relative viscosities of 7½, 7 and 6½.

The pasteurized cream from milk cooled but not aged before separating had a higher average viscosity than did similar cream from milk cooled and aged 15 hours before separating, the relative viscosities being 7 and 6½.

The average viscosity of pasteurized cream was slightly greater when the cream was aged as cream from cooled but unaged milk before being

pasteurized than when aged as milk before separating, the relative viscosities being 6 and 5½.

The viscosity of raw cream from milk aged 15 hours before separation was greater than that of cream from milk aged 3 hours or from milk separated immediately after milking and before cooling, the relative viscosities being 22, 17 and 9.

The viscosity of pasteurized cream from milk aged 15 hours before separating was slightly greater than that of pasteurized cream from milk aged 3 hours, but less than that of cream from milk separated immediately after milking and before cooling, the relative viscosities being 7, 6½ and 8.

The most viscous raw and pasteurized cream was obtained with a separating temperature of 80° F. as compared to others of 70°, 90° and 100° F., the relative viscosities of the raw cream being 57, 42, 32, and 7, and of the pasteurized cream 7½, 7, 7½ and 6.

These data would indicate that milk agitated during the cooling process, held for a period of 12 to 15 hours and heated to 80° F. for separation should give a more viscous raw cream than milk separated immediately after milking. The variations in results on cream after it was pasteurized were not very significant.

Raw cream testing 40 per cent butterfat cooled without agitation had a higher viscosity than when cooled with agitation or over a tubular cooler, the relative viscosities being 87, 58 and 79.

In the investigation dealing with time and temperature factors as related to the handling of cream, and their effect on its viscosity it was found that there was no very significant differences in viscosity of either raw or pasteurized cream testing 35 per cent butterfat:

When cooled in a water bath of 50° F. as compared to one at 35° F.

When cooled with and without agitation.

When cooled slowly without agitation in a water bath of 50° in the early part of the cooling process and in a bath of 35° in the latter part as compared to cream cooled over a tubular cooler to 48° F. and to 40° F. without agitation in a water bath at 35° F.

The viscosity of pasteurized cream which had been cooled and aged 15 hours before being pasteurized had a slightly, though not significantly, higher viscosity than did cream cooled but not aged or aged three hours before being pasteurized, the relative viscosities being 8½, 8 and 8.

M22. A Study of the Adaptability of the Vacuum Seal for Milk Bottles.

W. H. BROWN, P. H. TRACY, AND M. J. PRUCHA, University of Illinois.

One of the recent developments in the market milk industry is the adaptation of a vacuum cap for regular milk bottles. A metal cap with

a rubberized gasket is used. The usual vacuum of 18–24 inches is secured by expelling the air in the bottle above the liquid level with a jet of steam immediately preceding the placement of the cap. When properly sealed, the contents of the bottle can not leak nor can the milk be removed until the vacuum is broken by puncturing or prying off the lid.

To determine the practicability of the vacuum seal, a study has been made of its relation to creaming, re-creaming, ease of mixing, uniformity of vacuum, bacterial growth, and flavor changes during storage. Information has been secured also as to the consumer's reaction toward this type of cap.

The vacuum did not affect the initial creaming of the milk from the standpoint of either time to form or depth of cream layer. Milk in vacuum capped bottles re-creamed slightly slower than that in regularly capped bottles, and the depth of the layer of cream was reduced to a greater extent by the re-creaming process.

The ease of mixing the cream and milk at the end of 24 and 48 hours was not found to be affected by the vacuum.

Under practical conditions the amount of vacuum obtained has been found to vary considerably from bottle to bottle, and also with the same bottle. The limits of variation between bottles has been found to be from 15 inches to 24 inches, the average vacuum being around 20 inches. The amount of vacuum variation with the same bottle has been as high as 6 inches with the average around 3 inches.

Over a period of a month, there was found to be no measurable increase in pressure in 72 bottles of milk held at 32°–40° F.

The most important factor in determining the amount of vacuum is the fullness of the bottle when capped. A greater vacuum was obtained when not less than 5 cc. or more than 65 cc. of milk was removed. The greatest vacuum was secured when approximately 35 cc. of milk was removed.

From a bacteriological standpoint, the data tend to show that when the milk was held one week or less at 40° F. the increase or decrease in number of organisms was not altered by the vacuum. However, this relationship depends altogether on the types of organisms present in the milk. When the milk was held a considerable length of time (3 or 4 weeks) less surface growth was observed in the vacuum sealed bottles.

Cappy or tallowy flavors usually developed more rapidly in the vacuum capped milk. When the milks were stored for long periods of time, there was usually less undesirable bacterial flavor development in the vacuum capped milks. This was thought to be due to the lessened amount of bacterial growth at the surface of the milk.

Consumer reaction toward the vacuum sealed bottle of milk, in general, was favorable. Out of 322 customers on the University milk route who

returned their questionnaire, 239 stated that they considered the vacuum seal a desirable cap for milk bottles.

M23. Instant Whipping of Cream by Aeration. C. A. GETZ, G. F. SMITH, AND P. H. TRACY, University of Illinois.

The methods used for whipping cream have always employed the principle of agitating the product by some mechanical means whereby gas (usually air) was entrapped by the partially clumped fat and existed in the gaseous state throughout all stages of the process. The method to be described here differs in that the gas which makes up the bubbles is first dissolved in the liquid phase of the product to be aerated. By a release of pressure, the gas is thrown out of solution in the form of small uniform bubbles evenly distributed throughout the cream, resulting in an increased volume of cream and a certain increased rigidity.

The solubility of gas varies directly with the pressure, according to Henry's Law, so that the amount of gas dissolved increases with an increased pressure of the gas in contact with the cream. The rate at which the gas dissolves can be hastened by shaking. When the product is saturated at elevated pressures, it is still in the liquid state. When the pressure is released by allowing cream to flow out of the pressure container through a dispensing valve, the gas that has been forced into solution by the elevated pressure comes out of solution, as soon as the pressure drops, in the form of small uniform size bubbles and a whipped or aerated product results.

From a health standpoint, the gas used should be odorless, tasteless, and non-toxic. Further, it should be soluble to the extent of 100 volumes of the gas at standard conditions in 100 volumes of water. The gas found to be most successful was nitrous oxide (N_2O). However, carbon dioxide (CO_2), difluor-dichlor-methane (CCl_2F_2) and dimethyl oxide (CH_3OCH_3) or mixtures of these gases can be used although they are less satisfactory.

Microscopic studies have shown that the gas bubbles are of uniform size and that the butterfat globules are reduced in size during the whipping process.

Creams of 20 to 40 per cent butterfat have been aerated with equal success as far as increased volume is concerned. Since most consumers prefer whipped cream that is sweetened and flavored, most of the studies have been carried out with a cream containing 6 to 10 per cent sugar and a small amount of vanilla.

The results show that the overrun obtained is directly proportional to the pressure at which the cream is saturated before release, and is independent of the percentage of butterfat content. Overruns of from 200 to 600 per cent have been secured with no indication of fat clumping. Raw

cream, pasteurized cream, homogenized cream, and reconstituted cream were aerated successfully. The overrun is dependent entirely upon the pressure at which the creams are saturated and upon the age of the cream. The best results were secured with unaged cream. An increased viscosity in the cream makes it more difficult to saturate the liquid phase with gas at any given pressure.

For the commercial application of the process, it has been found that unaged cream testing 35 per cent fat (before adding sugar and flavoring) saturated with nitrous oxide at 80-90 pounds partial pressure is satisfactory.

M24. The Influence of Method of Sterilizing Equipment upon the Development of Oxidized Flavor in Milk. A. C. DAHLBERG AND D. C. CARPENTER, New York Agricultural Experiment Station, Geneva.

Exposure of milk at the pasteurization temperature to certain metals increased the iron and copper content of the milk and greatly accelerated the development of oxidized or cappy flavor. The solution of metals was not affected, in these experiments, by the method of sterilization of the equipment but the development of oxidized flavor was most pronounced when chlorine sterilization was employed. Hence, the amount of dissolved copper and iron was not the only factor involved when the milk exposed to these metals became oxidized. When the first hot milk through the equipment was discarded the pasteurized milk showed only a slight tendency to become oxidized especially if the equipment was sterilized with hot water or if chlorine sterilization was followed promptly by a hot water rinse.

Milk as secreted by the cow contained 0.131 parts per million of copper and 0.379 parts per million of iron. After pasteurization of the milk and after the first milk through the equipment was discarded the copper content of pasteurized milk was 0.186 p.p.m. and the iron content was 0.401 p.p.m. These data are relatively low when compared with other data in the literature.

M25. Modified Medium and Incubation Temperatures as They Affect Bacteria Counts of Milk Containing Organisms Arising from Various Sources of Contamination. ALEC BRADFIELD AND H. B. ELLENBERGER, University of Vermont.

It has been demonstrated that media and incubation temperatures, other than those recommended by Standard Methods, are capable of producing higher counts on composite samples of milk.

In addition to further investigation into this matter, this work consisted of an endeavor to ascertain which sources of the contamination of milk sup-

plied the organisms responsible for the increased growth on a modified medium and/or incubation temperature.

Comparisons were made on the Standard Medium and on one composed of Tryptone, glucose, skimmilk and agar, according to the formula of Bowers and Hucker (1935). Incubation temperatures of 37° C. and 32° C. were compared and also combinations of these media and incubation temperatures on the following:

1. Samples of both raw and pasteurized milk including ordinary contamination from all sources.
2. Milk drawn directly from the udder with as little outside contamination as possible.
3. Milk contaminated by poorly washed and sterilized milking machines.
4. Milk contaminated from milk cans containing large numbers of organisms.
5. Milk contaminated by various forms of stable contamination such as dirt from cow's body, manure, bedding, stable dust and feed.
6. Milk held at various cooling temperatures for periods of time up to 60 hours.

Also various types of skimmilk powders were compared as a source of milk for use in media.

An incubation temperature of 32° C. was a greater influence in producing higher colony counts than was the modified medium.

The combination of Tryptone-glucose-milk agar and 32° C. incubation temperature gave the highest counts in the greatest number of instances.

With both raw and pasteurized milk derived from deliveries to commercial milk plants the lower incubation temperature, 32° C., had a greater influence in producing high counts than did the modified medium, but the latter also increased the counts from pasteurized milk.

Milk contaminated from utensils gave the highest counts when plated on the modified medium and incubated at 32° C.

This combination also gave the highest counts when applied to milk that was improperly cooled.

The Standard medium incubated at 37° C. produced as great a number of colonies as any of the other combinations, on milk that contained few or no bacteria other than those derived from the udder.

The results with body contamination gave no significant differences; with feces contamination the Standard medium at 37° C. gave somewhat higher counts; with bedding, dust and feed contaminations the 32° C. incubation temperature gave a more marked advantage in higher counts than did the modified medium which, however, showed some advantage at 32° C. but not at 37° C.

The Tryptone-glucose-milk agar produced larger and more discernible colonies than did the Standard medium, and this factor was of great assistance to accurate counting.

Good quality skimmilk powder is equal in value to raw skimmilk as an ingredient for a medium for milk plating. There was no significant difference between the various types of skimmilk powders used as regards numbers of colonies developing on the plates but difficulty was experienced in incorporating some of them in the media.

These observations indicate that the Tryptone-glucose-milk agar and an incubation temperature of 32° C. would be of more value in milk control work than the Standard media incubated at 37° C. Significantly higher counts were produced on milk which had been exposed to improper methods of cooling and utensil contamination, and somewhat higher counts when the contamination was from stable dust, bedding or feed. When the contamination was from the udder, cow's hair, and feces, there was no significant difference in the counts; therefore, this modified method would aid in detecting poor milk without unduly penalizing clean, high quality milk.

M26. The Present Status of the Proposal to Change the Composition of the Agar and Temperature of Incubation of the Standard Agar Plate Technic of the American Public Health Association. ROBERT S. BREED, New York Agricultural Experiment Station, Geneva.

As the result of the recommendation by Bowers and Hucker (Amer. Jour. Pub. Health, 26, 350-353, 1936) and others that the present standard agar used in official milk analysis be changed in composition to a tryptone-glucose-skimmilk agar, and the recommendation by Yale and Pederson (Amer. Jour. Pub. Health, 26, 344-349, 1936) and others that the standard incubation temperature of 37° C. be lowered to 32° C., numerous comparative studies are being made in public health, milk dealer and private laboratories to determine the advantages and disadvantages that would result from making such a change. In a general way, other laboratories are finding that the improved agar does result in counts that are higher, especially on certain types of samples, than those secured with the present standard agar. Occasionally counts are higher on the present standard agar, but in these cases the difference in count is normally not so large as it is when the conditions are reversed. Larger and more frequent increases in count occur in pasteurized milk than in raw milk and these discrepancies in count become more evident the poorer the quality of the pasteurized milk.

It is becoming increasingly evident that a lowering of the temperature of incubation from 37° C. to 32° C. plays a greater part in producing irregularly increased counts than does a change in composition of the agar. These increases in counts seem to be due to a better growth of streptococci in the case of raw milk and partially also in the case of pasteurized products. In pasteurized products, particularly those that have been stored for some time at a low temperature, such as cream and ice cream mix, this increase in count

seems to be more largely due to the growth of bacteria that find 37° C. too warm than it is to the growth of heat-resistant and facultative thermophilic types. There is no one temperature of incubation that will grow all types of bacteria that should be detected and eliminated if the quality of our milk and cream supplies is to be maintained at the highest level. The present 37° C. temperature is poorly selected as it is too warm for many types of bacteria and too cold for the thermophilic types. It is above the optimum temperature for many types of pathogenic bacteria.

Research workers who feel that they can suggest a medium of a more satisfactory character than the one suggested by Bowers and Hucker are requested to submit evidence supporting their claims as soon as possible to the Committee on Standard Methods for the Examination of Dairy Products of the American Public Health Association. The cooperation of all those who feel that the present technic should be improved is requested in order that the final decision in this matter may be based on the best available knowledge.

M27. *Streptococcus lactis* in Raw and Pasteurized Milks of Very High Quality. E. S. YAWGER, JR., AND J. M. SHERMAN, Cornell University.

It is well known that *Streptococcus lactis* is seldom obtained when isolations are made from quantitative plates prepared from fresh milk of very low bacterial content. It is also well known that when such milks are allowed to spoil at temperatures of 20° C. or above, the lactic acid bacteria frequently do not dominate the other organisms so as to produce a normal souring. These facts have led some to doubt even the presence of *Streptococcus lactis* in milks of very high quality, especially when these milks are pasteurized.

With the use of proper selective methods, we have found that in raw milks having total bacterial counts of less than 10,000 per cc., *Streptococcus lactis* is usually present in numbers ranging from about 10 to 100 per cc. In pasteurized milks of equal quality and containing usually less than 100 living bacteria per cc., *Streptococcus lactis* has usually been found present to the extent of about one per cc. of milk.

M28. The Characteristics of Freshly Isolated Cultures of *Lactobacillus bulgaricus*. J. M. SHERMAN AND H. M. HODGE, Cornell University.

Although *Lactobacillus bulgaricus* is usually considered to be a milk organism, it has been seldom, if ever, isolated directly from fresh milk. Other lactobacilli, especially *L. casei*, are readily obtained from milk, and these organisms have doubtless been confused with *L. bulgaricus* by some workers. Our knowledge of the true *L. bulgaricus* is largely limited to a

few laboratory cultures most, if not all, of which were originally isolated from fermented milks or freshly made Swiss cheese. We have recently isolated more than 200 cultures of the bulgaricus group from fresh milk, and in a few characteristics these freshly isolated cultures depart from the conventional laboratory strains.

As heretofore described, *Lactobacillus bulgaricus* has among other properties the following characteristics: ferments glucose and lactose; does not ferment unheated fructose, maltose, sucrose and the higher carbohydrates, and related substances; produces a large amount of acidity in milk; is facultative with respect to oxygen requirements; and has a maximum temperature of growth around 50° C. The freshly isolated strains differ from the conventional laboratory cultures in the production of only about one per cent lactic acid in milk, in being strongly anaerobic, and in having maximum temperatures of growth at about 60° C. Only a very few of the freshly isolated cultures have maximum growth temperatures around 50° C.

In our collection are some fifteen cultures of a definite variety, or species, which ferment sucrose. The sucrose-fermenting strains produce from 1.25 to 2.0 per cent acid in milk and have somewhat lower maximum temperatures of growth. This variety corresponds to the organisms which have been erroneously classified by Swiss and American workers as the *Thermobacterium* (*Lactobacillus*) *lactis* of Orla-Jensen.

We also have a few cultures which agree perfectly with Orla-Jensen's *Thermobacterium lactis*. This organism ferments fructose, maltose, sucrose and mannitol, in addition to glucose and lactose. However, it very definitely belongs in the "bulgaricus group" as opposed to the "acidophilus group," and may be readily differentiated from the latter by a number of characteristics which cannot be detailed here.

M29. The Heat Resistance of Colon Organisms in Milk. C. N. STARK AND MARY CAROLINE PATTERSON, Cornell University.

During recent years more importance has been attached to the presence of colon bacteria in pasteurized milk. Much of the sanitary and public health significance which may be attributed to the finding of these bacteria in pasteurized milk depends upon their heat resistance in milk. Many conflicting statements concerning their resistance to heat are present in the literature.

The heat resistance of 505 pure cultures of *Escherichia-Aerobacter* organisms recently isolated from water, raw and pasteurized milk, and human and bovine feces, have been tested. The milk, inoculated from 24-hour cultures grown in nutrient broth, contained about one hundred million test bacteria per cc. Triplicate tubes of this inoculated milk were immediately tested. All "inconsistencies" were carefully checked. Four hundred eighty-seven, or 96 per cent of the cultures tested failed to survive 140° F. for 30 minutes. Of the remaining 18 cultures tested, 14

were destroyed by 143° F. for 30 minutes; the 4 cultures which resisted 143° F. were destroyed by 145° F. for 30 minutes.

The results of these findings, it is believed, tend to show that the presence of colon bacteria in pasteurized milk is due, in the majority of cases, to recontamination.

M30. The Significance of Bacterial and Chemical Changes Occurring in Mastitis Milk and Their Correlation with Milk Production.

L. A. BURKEY, G. P. SANDERS, AND J. F. CONE, Bureau of Dairy Industry, U. S. D. A.

A mastitis study made by weekly examination of fore-milk from first-calf heifers has shown that a more or less definite sequence of changes occurs in the milk coincident with the progress of the disease.

Milk may contain several hundred thousand leucocytes and several hundred *Streptococcus mastitidis* per cc. (plate count) without showing any chemical or physical abnormalities indicating mastitis.

There are frequently cases in which the milk contains large numbers of leucocytes and fibrin clots and may even show abnormalities in rennet curdling properties without the presence of a detectable number of invading organisms. This inflammation, although it may not be considered mastitis, probably provides conditions favorable to the invasion of *Streptococcus mastitidis*.

In a streptococcic infection the milk contains large numbers of *Streptococcus mastitidis*, and millions of leucocytes, and shows other indications of mastitis such as loss of rennet curdling properties, increase in percentage of chlorides and a marked reduction in milk yield. During the peak of the infection the numbers of streptococci and leucocytes in the milk reach a maximum, the chloride content usually is over 0.14 per cent, there is a complete loss in rennet coagulating properties, the pH is markedly increased, there is a large increase in the percentage of non-casein nitrogen, and there is a further drop in milk yield. At the time the infection begins to subside the invading organism disappears, the pH of the milk increases to a maximum, leucocytes are reduced in numbers, there is a prevalence of body cells, and the percentage of chlorides is reduced. As the cow recovers from the infection the milk becomes normal with respect to the percentages of chlorides and non-casein nitrogen, the pH returns to normal, the rennet curdling properties are gradually restored, the number of body cells remains large, and the milk yield usually remains low throughout the remainder of the lactation period.

M31. Frequency of the Escherichia-Aerobacter Species in Commercial Butter. E. H. PARFITT, Purdue University.

During the past year there have been analyzed over 1000 samples of butter coming from 60 different plants. In addition to the routine analysis,

an analysis was made for the presence of the *Escherichia-Aerobacter* species of organisms in 0.1 ml. of butter using the sodium formate-ricinoleate broth that has been proposed by Stark.

16.91 per cent of the samples in 0.1 ml. quantities produced gas, of this number 10.09 per cent were designated as *Escherichia*, 5.43 per cent as *Aerobacter* and 1.38 as being doubtful, when confirmed on Levine's eosin methylene blue agar.

Of the 50 plants which had submitted 12 or more samples, 8 manufactured butter that did not contain organisms that produced gas in Stark's media during the period of analysis.

The highest percentage of samples showing *Escherichia-Aerobacter* organisms was found during July and August of 1935 when 30.8 per cent of the samples were positive and the lowest in January, 1936, when 3.47 per cent were found to contain *Escherichia-Aerobacter* types. However there was not found a definite seasonal trend.

No relation was found between the yeast and mold count of the butter and the presence of *Escherichia-Aerobacter* organisms or between the keeping quality of the butter and the presence or absence of the *Escherichia-Aerobacter* group in the butter.

M32. A Comparison of Media Used for Determining the Bacterial Content of Ice Cream. F. J. BABEL AND E. H. PARFITT, Purdue University.

The microbiological analysis of 133 samples of commercial ice cream for total bacterial count and *Escherichia-Aerobacter* content has been made by using different media.

Tryptone-glucose-skimmilk agar as proposed by Bowers and Hucker gave higher total counts than did standard nutrient agar or standard nutrient agar plus one per cent sucrose. Greater differences in count between media were secured in those samples whose bacterial content was less than 50,000 per ml.

A greater percentage of samples showed the presence of the *Escherichia-Aerobacter* group of microorganisms when 0.1 ml. quantities of ice cream were inoculated into sodium formate—sodium ricinoleate broth and brilliant green bile than when plated on Leifson's sodium desoxycholate agar or violet red bile agar. The difference found between the two broths was negative. Violet red bile agar gave a higher percentage of positive samples and higher counts than did the medium proposed by Leifson.

The data indicates that samples of ice cream having *Escherichia-Aerobacter* counts of over 500 per ml. were samples with high total counts, and samples low in total count were found to have low or negative *Escherichia-Aerobacter* counts.

A direct relationship was found between the yeast and mold count as determined on acidulated potato dextrose agar and the total count as determined on standard nutrient agar, indicating the value of the yeast and mold count as an index of sanitation.

M33. The Effect of Certain *Penicillia* on the Volatile Acidity and the Flavor of Iowa Blue Cheese (Roquefort Type). C. B. LANE, Iowa State College.

Iowa blue cheese, a Roquefort type made from cows' milk, has been manufactured successfully for several years at the Department of Dairy Industry, Iowa State College.

The amounts and type of volatile acids produced in Roquefort type cheeses are of primary importance from the standpoint of the cheese flavor. Investigators have shown that the characteristic peppery flavor of Roquefort cheese is due, in a large part, to the accumulation of certain fatty acids in the cheese during ripening. Presumably, these products result largely from the hydrolysis of some of the cheese fat by enzymes of the *Penicillium* molds.

It is logical to assume that individual strains of penicillia would show variations with respect to their action on the cheese fat in which case certain strains might be more suitable than others for the normal ripening of the cheese.

Eight different strains of molds, isolated from various samples of Roquefort and blue cheeses, were employed in the experiments. Several lots of cheese were made and the curd of each cheese in the lot was inoculated with one of the mold strains. The total volatile acidity of each cheese was determined at various periods during the ripening, and at the same time barium salts were prepared from the volatile acid distillates. The cheese was also examined organoleptically and scored for flavor.

The total volatile acidities of all of the cheese increased as the ripening progressed. There were, however, large variations in the amounts of volatile acids among the cheese in the same lot, which indicate that the strain of mold used has a definite effect on the amount of volatile acids produced. The barium values obtained on the salts of the volatile acid distillates of the various cheese appeared to decrease after continued ripening. Presumably, there was a greater percentage of fatty acids of higher molecular weight in the older than in the younger cheese. With the different cheese in a lot, only very slight variations were shown in the barium values obtained. Apparently, the strain of mold used has little effect on the types of volatile acids produced.

The strain of mold employed seemed to influence the flavor of the cheese considerably. Certain strains regularly produced cheese having the characteristic peppery flavor of typical Roquefort in a relatively short time, while cheese made with other strains either lacked flavor and aroma or de-

veloped off flavors. The cheese containing comparatively large amounts of volatile acids regularly had much of the sharp, peppery flavor, while the cheese containing small amounts commonly lacked flavor.

One strain of mold appeared to be superior, from the standpoint of cheese ripening, to any of the others employed. This strain is now being used exclusively in the manufacture of Iowa blue cheese.

M34. Sanitary Aspects of Homogenized Milk. M. J. PRUCHA AND P. H. TRACY, University of Illinois.

Homogenization of milk breaks up the fat globules into globules so small that they cannot rise to the surface. It also makes the curd softer, and imparts to the milk a pleasant, rich taste.

Homogenized milk has not had, as a rule, as good keeping quality as the same milk not homogenized. This has led many milk sanitarians to question the wisdom of permitting homogenization of fluid milk.

This study attempted to answer two questions:

1. Why does homogenization affect the keeping quality?
2. Can it be remedied?

The keeping quality of homogenized milk is affected mainly, by the fact that the milk as it passes through the homogenizer picks up additional bacterial contamination. The homogenizer is a complex machine, and hence more difficult to clean and sterilize. This is especially true of the older machines.

The objection to homogenized milk is being corrected in two ways:

1. The improvement in the construction of homogenizers. The improvements have gone so far, that the new machines can be cleaned and sterilized just as easily as coolers, pumps, pipes and other equipment with which pasteurized milk comes in contact. In one dairy where a new machine was used the bacterial count of pasteurized milk was 230 and of the same milk when homogenized was 400.

2. The milk plant operators must learn how to take care of the homogenizer properly. In the dairy referred to above, the machine is taken apart after each use, it is washed in the usual way and treated with plenty of hot water, then air is blown through it to dry it. Just before it is used again, it is assembled, a chlorine solution, 60 ppm, is pumped through it, and then is rinsed with hot water.

There is no need to pass any laws prohibiting homogenization of fluid milk. Sanitarians should insist, however, upon proper cleaning and sterilizing. When so treated, the homogenizer will not be any more objectionable than other equipment such as coolers, pumps, and sanitary piping.

M35. Wrappers for Processed Cheese. HUGH L. TEMPLETON, University of Wisconsin.

In the manufacture of processed cheese the molten cheese mass is filled into foil-lined containers or forms and the foil is closed about the cheese

mass so that a complete and practically air-tight closure results. Tin foil is the most common material used for this purpose, and it is a rather expensive item in the cost of manufacture of this product. For this reason a number of substitutes have been proposed for the tin foil, and this paper presents the results of a study of a number of other foils and films which have been suggested.

Since tin foil is the most important wrapping material for processed cheese it has been the subject of considerable study. One of the defects commonly noted with tin foil is the darkening of the surface of the foil in contact with the cheese. This color change may vary from a dull gray cast on the surface of the foil to black spots and lines. In some instances the surface of the cheese may be discolored. A number of theories have been proposed to explain this discoloration of the foil, and these will be discussed briefly in connection with the presentation of data to show the effect of reaction and emulsifying salts on the color changes of the tin foil.

Aluminum foil has been advocated, but its use has been handicapped by some mechanical difficulties in handling. Pitting of the aluminum foil may occur as a result of interaction with the cheese mass and to eliminate this it has been necessary to cover the foil with a protective coating of shellac or one of the various types of synthetic resins.

Films of a cellulose or rubber-composition base have been tried to some extent, but they have not been satisfactory due to the fact that the cheese acquires a rather unpleasant surface taint.

M36. A Study of Inexpensive Milk Pasteurizing Units for Cheese Factories. WALTER V. PRICE, University of Wisconsin.

Pasteurization of milk for cheese has not been more widely adopted partly because of the cost of equipment. The investment in such machinery commonly exceeds the combined value of all other equipment in the average cheese factory.

Trials have been made to determine the efficiency of two methods of pasteurizing, one a low temperature, the other a high temperature treatment. Data on equipment operation, bacterial reduction, manufacturing losses, and comparative quality of raw and pasteurized milk cheese are presented. The results indicate the possibilities of placing the benefits of pasteurization within the reach of the average cheese factory.

M37. Salting and Cooking Curds in the Manufacture of Several Varieties of Cheese. J. C. MARQUARDT, New York Agricultural Experiment Station, Geneva.

The purpose of this study was to develop fundamental knowledge regarding the salting and cooking of cheese curds. As this work progressed the points of interest to practical cheese makers exceeded those of academic interest. The cheese varieties included in the study were cheddar, granular,

Monterey, brick and Camosum. The first four varieties were made from comparable milks and were used for the comparisons made.

This study has clearly indicated that cheddar and like cheeses should contain $1\frac{1}{2}$ to $1\frac{3}{4}$ per cent of salt. It has been possible to establish the reliability of various salting methods in making several varieties of cheese. As a result of this study it has been possible to determine the salt losses when adding varying amounts of salt to the curd. It has also been possible to prepare a salting schedule based upon the fat content of the milk. The table is presented herein.

In the cook studies the influence of variations upon flavor and texture were studied. Quality changes were least in the variety order of cheddar, granular, Monterey and brick. It was possible to make cheddar cheese of excellent quality with a moisture content far below that encountered in low moisture content commercial cheeses. Variation in composition influenced the quality of cheddar cheese the least of the varieties compared.

The study indicated that quality assurance was in the following order: cheddar, granular, Monterey and brick when comparable milks were made into several varieties of cheese. Although this has been previously accepted as a fact, organized data to support it have never been supplied.

It has been demonstrated that uniformity and quality are not attainable in making Camosum type cheese from the type of milk generally available where this farm type cheese is made.

The following table gives the amount of salt to add per 1000 pounds of milk varying in test in order to approach a definite percentage of salt in the cheese:

PERCENTAGE OF SALT DESIRED IN CHEESE	LOW		IDEAL		HIGH
	$1\frac{1}{4}$		$1\frac{1}{4}$	$1\frac{1}{4}$	2
Fat content of milk	Salt to be added per 1,000 pounds of milk				
3.0	1.3	1.7	2.0	2.5	
3.5	1.4	2.0	2.3	2.7	
4.0	1.6	2.2	2.6	3.2	
4.5	1.8	2.4	2.8	3.5	
5.0	1.9	2.7	3.1	3.9	
5.5	2.1	2.9	3.4	4.3	

M38. The Influence of Salt on the Composition and Quality of Brick Cheese. EVERETT L. BYERS AND WALTER V. PRICE, University of Wisconsin.

Brick cheese was made by the usual curdmaking procedures followed in the industry. Equal amounts of *S. lactis* and *S. thermophilus* cultures

were added each at the rate of 0.05 per cent. The influence of variations in the methods of salting were studied by treating identical curd by different procedures. The methods used were: dry salting, during which the cheese was salted lightly for three days after making; salting in 22 per cent brine for 24, 48, and 72 hours; salting in 26 per cent brine for 48 hours; and salting in 22 per cent brine for 48 hours but beginning the exposure four hours after dipping instead of the usual 20-hour interval after dipping. Each of these treatments was repeated with four different lots of milk.

The rate at which the salt penetrates the cheese depends on a number of such factors as method of salting, concentration of the brine, time of salting, moisture content of the cheese, and the like. The salt content is highest in the outside layer of the cheese during salting and lowest at the center. This difference gradually lessens until at four weeks of age the salt is practically uniformly distributed. There is a more rapid transfer of salt into the center of the cheese in brine salting than in dry salting. There is also a more rapid penetration with the higher concentration of brine.

As the concentration of salt is increased in the cheese by various treatments, the percentage of moisture tends to decrease. The pH of the cheese does not seem to be closely related to changes in salt or moisture during the curing process. Increasing salt concentration affects the quality of the product. The flavor in the ripening cheese develops more slowly and approaches that of Cheddar or Edam cheese as the taste of salt becomes evident. The body of the cheese becomes stiff and brittle as salt concentration is increased beyond the desirable maximum. The texture of the cheese may show a characteristic splitting when the cheese lacks salt. Increasing salt, however, does not seem to produce close texture. The color tends to become white as the salt content is increased beyond the desired maximum. The desirable amount of salt approximates 2.2 per cent of the weight of the cheese. This concentration may be attained by either dry or brine salting but greater uniformity is possible by brine salting. Care must be exercised, however, to regulate the duration of brine salting according to the concentration of the salt bath.

M39. The Utilization of Whey in the Preparation of Some New Food Products. B. H. WEBB AND G. A. RAMSDALL, Research Laboratories, U. S. D. A.

Whey contains approximately half the food solids of milk but although its nutritional value is great it is still almost entirely a waste product or in some cases a stock food. This situation exists largely because whey itself does not have a pleasing taste and because special uses have not been developed for it.

The successful use of whey as a food constituent must depend upon the utilization of its unique properties. The chief distinguishing characteristic

of whey is its lack of casein. This deficiency has been found to be a distinct advantage in the preparation of certain types of food products.

Condensed whey, whey powder, and whey cream have been successfully substituted for milk and cream in canned soups. Less difficulty is experienced with coagulation when a unit weight of whey solids is used than is found after the addition of a similar quantity of milk solids. A soup containing whey solids retains more of its natural color than does a milk soup. Whey solids impart the characteristic milk flavor to soups and greatly increase their nutritive value over products containing no milk solids. The rôle of the various soup constituents was studied and the optimum amount of whey to use was determined.

Normal milk or cream cannot be combined with acid fruits or fruit juices without inducing coagulation of the casein. Various forms of whey solids have been found to be well suited to use with acid foods. When the reaction of a fruit-whey solids mixture was adjusted below pH 4.5 a very low processing temperature could be employed and a cooked flavor avoided. Coagulation of the whey proteins was light and the coagulated particles blended unnoticeably with the fruit pulp. Butterfat was often added, generally in the form of whey cream. In this manner a line of fruit beverages, fruit whips, ice cream mixes for domestic freezing, and fruit flavored whipping creams have been developed. These products were packed and processed in tins and were found to possess excellent keeping quality. Formulae and details of manufacture were worked out.

Ready prepared products of this type should serve to increase the consumption of whey solids as a human food and they should be a great convenience to the housewife.

M40. A Pasteurizing Difficulty Experienced Where Whey Cream is Processed. L. C. THOMSEN, University of Wisconsin.

The cheese industry is now so widespread that difficulties occasionally experienced in the pasteurization of whey cream in Wisconsin may be expected in other states as well. When whey cream is mixed with ordinary farm or factory skimmed cream, curdling during pasteurization may take place at infrequent intervals. Since such curdling does not occur regularly in the same plant, the assumption may be made that this difficulty results only when the mixture has the proper proportion of each, or if the acidity of the two creams is favorable for such curdling, or if the solids-not-fat content is of a definite percentage.

Experimental work was undertaken to determine which of the above factors were responsible, and to what degree. Results indicate that the relative amounts of each cream used, and the acidity of the cream have a definite effect on the amount of curd developed.

The difficulty may be overcome by preheating the whey cream to the pasteurizing temperature before it is added to the regular cream.

M41. A Summary of Results of Experimental Studies of Certain Factors Affecting Churning Losses. H. A. DERBY, D. F. BREAZEALE, AND E. W. BIRD, Iowa State College.

The churnings herein reported were conducted in Cherry Junior churns; it is considered that they are representative of factory conditions. In each group of experiments it was endeavored to hold all conditions constant except the one under consideration. For this reason all churnings were made during the season of "winter fats." The accumulation of these data has extended over a period of five or six years. The fact that excellent correlation exists among data for different years adds weight to their validity.

Primarily fat losses were the chief interest; churning times were recorded. The factors studied were (1) effect of variation of fat content in the cream, (2) the effect of the variation of the protein contents of the cream (3) the effect of change in acidity of the cream (titratable acidity of cream and buttermilk and pH of buttermilk were determined) with fat levels of 20, 30, and 37.5 per cent fat. In part (3) the range in pH of buttermilk studied was from approximately 4.5 to 7.0.

The results of the study indicated that:

(1) a. Fat losses, calculated as percentage of the fat churned, are a continuous and reducing function of the fat percentage of the cream from 20 per cent cream (loss approximately 2.4 per cent) to approximately 30 to 35 per cent cream (from 1.4 to 1.6 per cent fat loss). In this neighborhood a point of inflection occurs; the loss curve continues to approximately 37.5 per cent fat (from 1.19 to 1.4 per cent), and then rises slightly to 40 per cent cream.

b. The churning times vary with a minimum value for sweet and neutralized cream in the vicinity of 30 to 32.5 per cent cream. With slightly ripened cream the minimum time lies more closely at 25 per cent fat cream.

(2) From protein analyses of the buttermilks of several sweet cream runs the total protein, casein, and heat coagulable proteins in the creams were calculated. The fat losses appear to be more nearly dependent on the casein or total protein contents than on the albumen contents.

(3) a. The results for 20, 30, and 37.5 per cent fat creams yield fat loss (as per cent total fat churned) buttermilk pH curves that are unlike for each of the fat percentages studied. It is considered that this is substantiation of the contention that an actual point of inflection, of the fat-loss, per-cent-fat-in-cream curves, exists.

b. The 20 per cent pH loss curve shows an ill defined minimum at buttermilk pH 6.0-6.25, a marked maximum at pH 4.8-4.9, and a sharp nearly linear drop in loss from this point to pH 4.5.

c. The 30 per cent pH loss curve gradually drops from pH 7.2 to 5.8, is practically constant from pH 5.8 to 5.0, and breaks between pH 4.85 and 5.0 with a downward trend not nearly as steep as with 20 per cent cream until pH 4.5 is reached.

d. The 37.5 per cent pH loss curve bears no relationship to either of the preceding curves except that of a marked change in function at pH 4.8. Minimum loss points occur at pH values 5.45 and 6.2, a poorly defined maximum exists at pH 5.75, and a sharply defined one at pH 5.8 to 5.9.

e. There is no apparently good correlation between churning time and pH or churning time and fat loss with 30 or 37.5 per cent fat creams. The churning time pH curve follows the same general trend as the fat loss pH curve for 20 per cent cream.

CONCLUSIONS

1. Casein seems to play an important part in influencing the trend of churning losses.

2. Under practical conditions the churning time seems not to correlate with either fat loss or pH of cream, for cream with fat percentages of 30 per cent or greater. There is definite correlation among these three factors for 20 per cent cream.

3. The maximum loss point corresponds very well (pH 4.8–4.9) with the points of lowest surface tension for casein and albumen solutions reported in the literature. This would indicate that surface tension and perhaps viscosity effects may be of importance in determining the type of loss curve with change in pH.

4. The data indicate that on the whole a loss of 1.2 per cent of the total fat churned approximates, if it does not reach, the minimum loss possible under practical conditions. This indicates a possible yield in the churning process of 98.8 per cent which is exceptionally good.

5. The pH, fat-loss curves make possible direct comparison between the fat losses under the American (low acid-high fat) churning practice and that practiced in certain sections of Europe (low fat-high acid). They show that insofar as yield is concerned the American system is as good if not slightly better than the European.

M42. A Preliminary Report of the Effect of Certain Neutralizers on the Churning Loss and the Keeping Quality of the Butter. D. F. BREAZEALE, N. E. FABRICIUS, AND E. W. BIRD, Iowa State College.

The neutralizers in this study are grouped in four classes: 1. highly buffered—trisodium phosphate, 2. relatively strong alkalies—sodium hydroxide and sodium carbonate, 3. relatively weak alkalies—sodium bicarbonate and sodium sesquicarbonate, and 4. lime neutralizers—magnesium limes

and calcium limes. To date 16 runs with trisodium phosphate, sodium hydroxide, sodium bicarbonate, and a magnesium lime have been made.

The following data runs have been obtained from these runs: a. pH of original cream, b. pH of cream after neutralizing (sample held without starter in the same cooler in which the cream to which starter was added was held; pH values were run at churning time), c. pH of cream (to which starter had been added) at churning time, d. pH of butter serum at beginning of storage period, e. pH of butter serum at end of storage period, f. acidity of fat of butter, g. acidities of the creams at the times that pH values were determined, h. per cent salt in butter serum, i. scores of butter at beginning and end of storage period, j. Mojonnier test of buttermilk and k. Babcock test of cream. The butter samples were stored 6 weeks at 28 degrees F. The data indicate that:

1. The churning losses calculated as the percentage of total fat in the cream follow the usual fat in cream-buttermilk loss trends, and that such differences in pH as occurred among the cream samples had no effect on the losses. There seemed to be no effect on the losses, generally speaking, of different neutralizers.

2. There seemed to be little correlation between quality of butter as indicated by judges' scores and a. pH of original cream, b. pH of cream after neutralization, c. pH of cream at time of churning, d. pH of butter serum and titratable acidity of butter fat from the butters as long as the pH at the time of churning lay within the ranges 5.9 to 7.5 for sodium hydroxide; 6.3 and 7.25 for trisodium phosphate; 6.1 and 6.9 for sodium sesquicarbonate and 5.8 and 6.5 for magnesium lime. These were the ranges covered. The following summary table shows the relationship between the average cream pH values and the average scores:

TABLE 1

NEUTRALIZER	pH AFTER NEUTRALI- ZATION. NO STARTER	pH AT CHURN. TIME. 7 PER CENT STARTER	SCORE OF BUTTER IN STORAGE	SCORE OF BUTTER OUT OF STORAGE	DROP IN SCORE
Sodium hydroxide	6.92	6.48	91.06	90.56	0.50
Trisodium phosphate	6.94	6.59	90.48	90.34	0.14
Sesquicarbonate	6.73	6.42	90.57	90.41	0.16
Magnesium lime	6.39	6.08	90.81	90.43	0.38

3. When plotted the pH value of the butter serum showed a definite relationship to the pH of the cream for each neutralizer although the slopes of the curves and their placement on the abscissa (pH of cream) varied somewhat. When the butters came from storage the pH values of magnesia lime neutralized samples seemed to have become somewhat higher in some samples.

4. The titratable acidity of the butter fat appears to be a function of the original cream. When the acidities are plotted against pH of sour cream they fall in groups at that pH value and the higher the acidity in any one group (*i.e.*, one cream sample) the lower the pH value for that sample and vice versa. If the average acid value for the group is plotted against the pH value of the sour cream a correlation appears to exist between these values.

5. When the pH values of the creams after neutralization or at the churning time are plotted against titratable acidities of their respective creams a different graph is obtained for each neutralizer. The general trend of these curves can be indicated by table 2.

TABLE 2

TITRATABLE ACIDITY OF CREAM	pH VALUE OF CREAM			
	Sodium hydroxide	Sodium sesqui- carbonate	Trisodium phosphate	Magnesium lime
0.30	5.50	5.75	6.10	5.90
0.20	6.25	6.35	6.75	6.20
0.10	7.10	7.10	7.40	6.70

These values seem logical since trisodium phosphate is a strong buffer, magnesium lime reacts with casein in such a way as to remove a part of it from the system, and both sodium hydroxide and sesquicarbonate are poorly buffered (for CO_2 is lost during pasteurization).

They likewise explain why, in general, less difficulty may be encountered with the magnesium limes than with the soda neutralizers. Section 3 above, however, indicates that, either because of hydrolysis of lime caseinates or for some other reason, the butter from lime neutralized creams may increase slightly in alkalinity during storage.

6. These data are too few (16 runs) to warrant drawing sweeping conclusions and should be considered as indications only. They do point out the need for reliable data (which it is hoped this study will yield) concerning optimum pH values that should be striven for in neutralizing cream with different neutralizers.

M43. Some Factors Influencing the Spreadability of Butter. S. T. COULTER AND W. B. COMBS, University of Minnesota.

A study was made of the effect of variations in the manufacturing process on the spreadability of butter. The avoidance of excessive cooling of the cream and of cooling cream to a low temperature over a surface cooler, the use of a relatively high churning temperature, and the proper use of low temperature wash water were found to improve the spreadability of butter. The most desirable butter body may not be associated with maximum spreadability.

M44. A Proposed Score Card for Judging Churning Cream. L. H. BURGWARD AND J. H. ERB, Ohio State University.

With the advent of cream improvement campaigns there has been a demand for a suitable churning cream score card. A scoring plan is suggested for general use, which bases the score of the cream on the score of the butter made from any given lot of cream. This score card has been used in a state-wide vocational high school cream judging contest. The allocation of points is as follows:

	<i>Perfect</i>	<i>Normal Score</i>
Flavor and Aroma	60	46-54
Sediment	10	5-10
Acidity	15	0-15
Per cent Fat	10	0-10
Container	5	3-5

In the paper the numerical cuts for various flavor defects are discussed. The standards for sediment, acidity, and butterfat are given. It is proposed that the association formulate a suitable universal score card for churning cream, which may serve as a basis for scoring.

M45. A Comparison of Pressure and Centrifugal Homogenization of Ice Cream Mixes. J. C. HENING, New York State Agricultural Experiment Station, Geneva.

In these studies ice cream mixes homogenized by pressure and homogenized with a centrifugal colloidal mill were compared for viscosity, size of fat globules and fat globule clumps. The texture and body of the ice creams prepared from these mixes were also compared.

The two stage homogenization of ice cream mixes at low pressures produced mixes and ice creams which were similar in the above mentioned properties to mixes processed with the centrifugal colloidal mill, except that the colloidal mill ice cream mixes contained no fat globule clumps.

When ice cream mixes prepared without gelatin were homogenized with pressures on the first stage ranging from 400 to 1000 pounds, decreasing at 500 pound intervals with a constant pressure of 500 pounds on the second stage, they showed a gradual decrease in viscosity from 4000 pounds to zero pressure. The colloidal mill mixes were a little less viscous than the un-homogenized mixes. The fat globules showed a slight increase in size from 4000 to 2500 pounds pressure with greater increases at each succeeding reduction in pressure.

The texture and quality of the ice creams were good at the higher pressures with a trace of coarseness at the 2500 pounds pressure. The ice creams prepared from mixes processed at the lower pressures were coarse and the

centrifugal colloidal mill ice cream was a trifle coarser than the unhomogenized ice cream.

When ice cream mixes prepared without gelatin were homogenized with a constant pressure of 2500 pounds on the first stage and the pressure on the second stage was decreased from 2000 to 500 pounds at 500 pound intervals, the 2500 first stage and 2000 pound second stage pressure mixes were more viscous, contained larger fat globule clumps and whipped a little less readily than the mixes with a greater difference in pressure between the first and second stage. The body and texture of the ice creams prepared from these mixes were similar.

Other tests using a pressure of 3500 pounds on the first stage and pressures ranging from 3000 to 500 pounds at 500 pound intervals on the second stage gave the same general results.

The texture and quality of the ice creams from the mixes processed by these two methods were approximately the same only when stabilized with 0.5 per cent of a medium grade gelatin and when the pressure homogenization on the first stage was below 1200 pounds.

M46. The Use of Sodium Alginate as a Stabilizer in Ice Cream. P. H. TRACY, G. L. GIBSON, AND S. L. TUCKEY, University of Illinois.

Sodium alginate, a derivative of a sea weed, kelp, gathered off the Pacific Coast of the United States has been compared with 225, 215, and 175 Bloom gelatins from the standpoint of their stabilizing action in ice cream. The action of sodium alginate in the mix was found to be more rapid than that of gelatin, so that aging is not so important a factor when using sodium alginate as when using gelatin. Ice creams stabilized with sodium alginate melted more rapidly when exposed to room temperature than did those containing gelatin.

When equal amounts of sodium alginate and 225 Bloom gelatin were used in the mix, ice creams of approximately the same body scores resulted. When the two stabilizers were so used there was little difference in the time required to reach 100 per cent overrun.

Mixes containing the sodium alginate, when examined with the K and E color analyzer, showed slightly more color than the gelatin mixes. When the sodium alginate was dispersed in the mix after homogenizing, a slight amount of visible sediments was detectable when a small portion of the mix was passed through a sediment disk.

Sodium alginate caused the mix to have a slightly lower titratable acidity and increased the pH reading.

M47. Recent Studies on the Use of Dextrose in Ice Cream. W. J. CORBETT AND P. H. TRACY, University of Illinois.

A study is in progress relative to the merits of replacing a part of the sucrose in ice cream with dextrose. Since dextrose depresses the freezing

point to a greater extent than does sucrose, it is desirable to replace only a portion of the sucrose with dextrose. When used in conjunction with sucrose, the hydrous dextrose has a sweetening value of approximately 83 while anhydrous dextrose has a sweetening value of practically 100, as shown by consumer tests.

Dextrose produces practically no effect upon color, does not have any effect on protein stability as measured by the alcohol test, does not effect the curd tension as determined by Hill curd test, and generally decreases the pH slightly depending on the time and temperature of pasteurizing. When the sugars are added before processing, dextrose mixes generally have a lesser viscosity than do sucrose mixes. However, in solution of gelatin and sugar in water this relationship does not hold true suggesting that dextrose possibly affects the degree of protein hydration in the mix.

The average overrun of mixes frozen on 10, 12 and 40-quart batch freezers shows that mixes made from part dextrose¹ and sucrose whip to 100 per cent overrun in the same length of time as do all sucrose mixes. It was found further that it does not take any longer to remove the heat from dextrose-sucrose mixes than from all sucrose mixes.

Dextrose ice creams should be dipped at lower temperatures to avoid excessive dipping losses. Comparative hardness tests show little difference in the resistance to penetration at temperatures below 0° F., but above this temperature dextrose ice creams are less resistant than the all sucrose ice creams. Dextrose ice creams melt down slightly more rapidly than do those containing all sucrose (percentage loss at end of 2½ hours from 2 to 5 per cent greater).

Dextrose mixes when frozen in the Vogt freezer have a lower drawing temperature than the all sucrose mixes. It was noticed that the bodies of the dextrose ice creams frozen on the Vogt freezer are heavier than those of the all sucrose products. This difference can be minimized by reducing the gelatin content of the dextrose mixes.

From 1322 consumer tests conducted during this study, it was shown definitely that dextrose sugar has no detrimental effect upon the flavor of ice cream. From the standpoint of body preference, the dextrose ice creams met with practically the same favor as did the all sucrose products. The slightly quicker melting and colder reaction on the tongue of the dextrose ice cream makes the use of dextrose in high solids ice creams, particularly during the summer months, of special value.

¹ Dextrose mixes refer to mixes in which one-fourth of the cane sugar has been replaced with dextrose.

EXTENSION SECTION

E1. Securing Qualified Testers. C. R. GEARHART, Pennsylvania State College.

Qualified testers should be:

1. Men well trained for their work as the job requires considerable knowledge and technical skill.
2. Men who will win the respect and confidence of the dairymen; congenial, honest and thoroughly sold on their work.
3. Young men with dairy farm experience.

Some difficulties experienced in locating men with the above qualifications, are:

1. Too often applicants for testers' jobs are interested only in the salary, or they take a job as a stop-gap until something more desirable appears.
2. Sometimes we find otherwise desirable men who hold an aversion to entering a new, strange home every day or two.
3. We often have difficulty in demonstrating to candidates for testers' jobs that the job presents unlimited possibilities for the study of dairy methods and feeding practices.
4. Then too, there is the difficulty in proving to testers that their job can, by its intelligent use, be made a stepping stone to other positions such as that of herd managers, county agents and salesmen with commercial companies who are affiliated with the dairy industry.

The problem of securing qualified testers harasses every D.H.I.A. Supervisor and in an effort to solve them we have summarized from a questionnaire submitted to such supervisors.

E2. Dairy Herd Improvement Association Supervisor's Conferences. M. J. REGAN, University of Missouri.

Dissemination of new information in the field of dairy husbandry, more complete records, a continued increase in the efficient use of dairy herd improvement association records, and the service rendered to its members as an organization, are major factors in the progress of dairy herd improvement association work in the United States. In the early stages of the development of dairy herd improvement association work, these factors could be dealt with on a personal service basis. Continued growth of organization, however, has made it necessary to handle these factors through the development of leadership and adopting the plan of group teaching. It has been found that approved practices can best be introduced and fostered through the supervisor of the local dairy herd improvement association. These supervisors may best be contacted in conferences where the details of proposed projects may be thoroughly explained.

The growth of dairy herd improvement associations, an increase in the service to their members, and new developments in agriculture make it apparent that a study should be made of some method of systematically and efficiently contacting all members. In an attempt to inaugurate a study of this kind, the following questionnaire was sent to the dairy extension specialists throughout the United States:

1. Do you hold testers' conferences?
2. If conferences are not held, what is the method of contacting testers?

3. If you hold conferences, do you make other personal contact with testers? If so, how often and by whom
4. Give the number of statewide conferences held yearly
Give the number of district conferences held yearly
What is the length of each conference?
5. Who handles the program? Does the extension dairyman a tester , or a county extension agent act as chairman? (Check the ones who act as chairmen.)
6. Do members of the resident staff , county extension agents , testers , extension dairymen appear on the program at the conference? (Check the ones who assist you on the program.)
7. Do you hold testers' conferences every year?
8. Who pays the testers' expenses while attending

9. Are your conferences considered a school for training new testers?
Is an additional training school held for new testers

Forty-seven questionnaires were sent out, and forty-one were returned. A summary of the forty-one questionnaires returned shows 19 states reporting as holding testers' conferences; 18 states reporting as never having held a conference; two states reporting as having discontinued this practice; one state reporting holding conferences "not regularly" and one state reporting as "planning to hold conferences this year for the first time."

The states not holding conferences, indicated that they contacted their testers through personal visits and correspondence. Most of the states not holding conferences contacted their testers with definite regularity. These contacts were made by the extension dairyman or the state supervisor.

Of the 19 states holding testers' conferences, 18 reported that the dairy extension man contacted each tester two or more times during the year in addition to the conference. Thirteen states hold one statewide conference each year; two states hold two statewide conferences each year, and most of

the states hold statewide conferences in addition to district conferences. District conferences in practically all cases are one-day conferences. The length of the statewide conferences in general, is from two to three days.

In three states the tester acts as chairman, and in thirteen states the extension dairyman is in charge of the conference. Members of the resident staff, extension dairymen, representatives from the U. S. D. A., testers and county extension agents appear on the program at the various conferences. Only three states reported using the conference as a school for testers. Eleven states reported that additional training schools were held for new testers. A sample conference program is as follows:

CONFERENCE PROGRAM

Spring 1936

First Day

10: 00-12: 00—Individual conferences. This time is for getting acquainted and for discussing individual problems. New testers are especially urged to take advantage of this time.

Afternoon

1: 00- 1: 15—This Winter's Job Well Done.

1. Status of testing.

1: 15- 2: 15—Changes in the testers' manual.

1. New herd books.

2. Automatic retest reports.

2: 15- 2: 45—National Soil Conservation Program and Its Probable Effect on Dairying.

2: 45- 3: 15—Pasture and Hay Crops in New Program for Agriculture.

1. Summer herd management.

2. Hay curing and hay storage.

3: 30- 4: 00—Dairy Calf Club Work.

4: 00- 4: 30—Testers' Narratives on the Air.

4: 30- 5: 00—General Discussion.

1. Keeping equipment in good shape.

2. Standard Associations.

3. Testers' Records and Reports Contest.

4. Mailing Lists, Changes—additions, etc.

Morning

8: 00- 8: 45—Our Better Sire Program.

1. Proving sires.

2. Bull record book project and better sire contest.

3. Sire index contest.

4. Sire exchange.

8: 45- 9: 15—Mutual Problems in Herd Testing.

1. How costs are handled.

2. Mistakes on reports.

3. Status of H.I.R. Testing.

9: 15-10: 00—Herd Analysis.

1. Germ Plasma Survey data.
2. Permanent herd books.
3. Future plans.

10: 15-11: 00—Planning Summer Programs.

1. Tours and picnics.
2. Field days of breed associations.
3. Dairy Cattle Congress Activities.
4. Exhibits.

11: 00-12: 00—General Discussion.

1. Scheduling dates.
2. Signing expense accounts.
3. Better Sire Committees.

E3. Combining Farm Accounts with D.H.I.A. Records. E. A. GAUNTT, New Jersey.

Although considerable thought has already been given to the possibility of combining farm accounts with D.H.I.A. work it is evident that the idea is still in the embryonic stage so far as most of the states, including New Jersey, are concerned.

Some few states have tried the combination and find that it works. Probably the pioneers in this field are Michigan and Wisconsin.

A. C. Baltzer, of Michigan, states that they tried the idea in 1932 and found the work so valuable that they have continued it with a small number of herds in each association. He states that by selecting five, or at the most ten, farmers in an association no unduly heavy burden is placed on the tester. The testers are paid \$3 extra for each completed record. Apparently Illinois thinks more of the record, as that state pays \$5 for each record and C. S. Rhode writes that the plan works.

Glen Vergeront, of Wisconsin, writes—"Of course you realize that this is just one more task for the cowtester who now has his hands full." Yet they too feel that the records are too valuable to give up and Mr. Vergeront stated that farmers have written in telling of their appreciation of such help.

Ramer Leighton, of Minnesota, states that they are trying it in two associations this year and may try it in four next year, but it is too early yet to predict the feasibility of the plan.

G. E. Gordon advises that the plan is not practical in California because most of their testers are handling 1,000 cows or more each month.

Floyd Johnston, of Iowa, writes that they had such a plan in mind about a year and a half ago but the Farm Management Department finally decided to organize separate farm business associations set up similar to a D.H.I.A.

Only those states having a considerable number of associations were questioned, hence other states may be doing this type of work. Nebraska, Ohio, Vermont, Connecticut and New Jersey are also considering the plan but have not put it into operation as yet.

Apparently there are two different ideas as to the type of this Farm Account record. Some want cost accounts, i.e., getting complete costs of producing milk, while others seem to be more interested in a simple record of cash income and outgo covering the entire farm operation.

In New Jersey the dairy and agricultural economics departments agree that they want the cash transactions on the entire farm set up as they feel that enough figures are available to work out total costs on milk production if the cash costs are complete. Furthermore, they have seen several instances of farmers having excellent herds of dairy cattle according to D.H.I.A. records and yet because of poor farm management practices they have gone bankrupt or lost their farms. In any county one such event creates a terrific handicap for D.H.I.A. work and in fact may jeopardize the entire extension set-up.

Since D.H.I.A. cooperators are considered demonstrators of better dairy practices the members of the New Jersey dairy department firmly believe that for our own protection, and particularly for the benefit of the farmer, we must try to work out some simple system for combining these two very important types of records.

E4. The County Agricultural Agent's Responsibility in Connection with a Testing Program. G. E. GORDON, University of California.

- I. County agent should actively supervise the testing program in his county.
- II. County agent should provide the contact between the state office and the tester and members of the association.
- III. County agent should direct tester activities.
- IV. County agent should supervise summarization of all reports and all publicity.
- V. County agent should contact individual members.
- VI. County agent should plan programs of activities in cooperation with the members of the association and the tester.
- VII. County agent should supervise plans for maintaining membership in associations.

E5. Handling Herd Improvement and Advanced Registry Testing in Connection with Cow Testing Associations. FLOYD JOHNSTON, Iowa State College.

Herd Improvement and Advanced Registry testing handled by the same staffs who supervise cow testing associations seems to be a distinct service to dairymen. Such a plan makes it easy for the breeders to test at a minimum cost. More herds and cows are tested in the states where the work is under the same supervision. Herd Improvement Registry testing as fos-

tered by the national dairy breed associations seems to strengthen cow testing association work and there seems to be no complications arise from the supervision of the Advanced Registry testing.

A study was made of questionnaires received from 40 states. The official testing (which includes advanced registry and herd improvement) in 17 of these states is supervised by the same staff as supervises the cow testing association work. Sixty-five and seven-tenths per cent of the herds on herd improvement registry test and 47.1 per cent of the cows on advanced registry test in the 40 states are in those 17 states. Fifty-five per cent of the cow testing associations in the United States with 59 per cent of the herds on test are in the 17 states.

There seems to be a definite trend for the supervision of official testing to be placed under the same staff in the Extension Services that supervise cow testing association work. This trend has been manifest most since the national dairy breed associations adopted the "herd test." Besides the 17 state where the supervision is already in the Extension Services 9 other states stated they had discussed making a change. The average length of time the Extension Services in the 17 states have had supervision of the official testing is 5.6 years with a range of from 6 months to 15 years. Six states have made the change since January 1, 1933, and 3 states have made the change within the last year.

The supervision of official testing in the 17 states requires on the average 21.1 per cent of the time of an Extension Dairyman and 36.8 per cent of the time of a clerk. Nine of the states reported an increase in the number of cow testing association members because of the supervision being under the same department and they felt the time justified. Two states reported a decrease in association members and 6 reported no effect one way or the other.

Twenty-six of the 40 states permit association testers to conduct advanced registry tests and all 40 states permit association testers to conduct herd improvement registry tests. Ten of the 17 states pay association testers extra for conducting herd improvement registry tests along with cow testing association tests. Only seven of the 17 states reported difficulty with testers becoming familiar with the breed association regulations. A remarkably few—only two—states reported any difficulty in the attitude of the breeders toward the Extension Services due to collections.

The range in the charges for a one-day test for advanced registry was from \$2.25 plus travel expense to a flat rate of \$10.00 with an average of \$5.43. The charges for herd testing ranged from \$2.25 to \$9.00 for a one-day test with an average of \$4.59. Of the 40 states 32 reported their testing departments were self-supporting if they excluded salary of superintendents; 3 states reported a loss and 5 states a profit.

A detailed summary of the study will be distributed in mimeographed form at the Extension Section meeting.

E6. Conducting a Bull Association Program. S. J. BROWNELL, Cornell University.

I PROMOTION

Bull associations are promoted.

- A. General Dairy Meeting.
- B. Breeding Schools.
- C. Sire campaigns.
 - a. Publicity.
 - b. Lessons.
 - c. Better bull bulletins and letters.

II REQUIREMENTS FOR ORGANIZATIONS

Before a bull association is organized there are five qualifications on which all prospective members must be in accord.

- A. Disease.
- B. Quality and price of bulls.
- C. Record keeping.
- D. Housing and management of bulls.
- E. Compatibility.

III OPERATION

- A. To be recognized as a bull association there must be:
 - a. An adopted constitution and by-laws.
 - b. Not less than three blocks.
 - c. Three or more bulls transferred on the herd books of the National Breed Association to the Bull Association.
 - d. Not less than one meeting held each year.
- B. Bulls are rotated every two to three years in the numerical order of the blocks, to avoid inbreeding. A young bull is added every two to three years. This bull is kept as a spare to be used in emergencies and rotated every three months for sampling. This starts new bulls with a minimum of breeding risk to each member.
- C. Bulls are paid for by assessments levied equally on each block and the cost within the block is distributed among the members of that block in proportion to the number of females in each herd that is of breeding age.
- D. A block consists of one or more dairymen who will support an association bull.

IV SUPERVISION

The Dairy Husbandry extension specialist of each state is responsible for the success of each association within his state.

- A. He promotes the association on a sound basis.
- B. He assists with the formation of a good organization.
- C. He establishes a system of records for the bull keepers and secretary-treasurers.
- D. He supervises a program of meetings, education and work.
- E. He arranges for and attends each annual meeting where he:

- a. Visits every member.
 - 1. Inventories every herd for progress.
 - 2. Checks type and quality of the offspring of the association bulls.
 - 3. Discusses the problems and successes with each member.
- b. Visits the bull keepers.
 - 1. Checks the breeding record of the bull for fertility and sterility.
 - 2. Checks the service fees collected.
 - 3. Prepares the bull keepers annual report
- c. Visits the secretary-treasurer.
 - 1. Audits the books.
 - 2. Checks the secretary's book.
- d. Visits the President.
 - 1. Provides an order of business
 - 2. Discusses the problems that will come up before the meeting.
- F. At the annual meeting the specialist guides the meeting according to the problems located during the day and addresses the meeting on the successes gained and points out the future program.
- G. Following the meeting he prepares the records of the organization.

E7. The Future Dairy Herd Improvement Association Sire Program.
E. E. HEIZER, Ohio State University, AND J. F. KENDRICK, Bureau of Dairy Industry, U. S. D. A.

The suggested Future Dairy Herd Improvement Association Sire Program provides for the following organization:

- A. Phases centralized in the Division of Dairy Herd Improvement Investigations, Bureau of Dairy Industry.
 - 1. Positive identification of all animals in the Dairy Herd Improvement Association herds. A uniform identification system is presented.
 - 2. Organization of a permanent record system for keeping life-time lactation records of all cows tested in Dairy Herd Improvement Associations, as well as dam and daughter records, for use in the National Dairy Herd Improvement Association Sire Program.
 - 3. Periodical publication of a proved sire list.
- B. Phases of the program decentralized in the Extension Divisions of the various states.
 - 1. Uniform methods for conducting bull association work. (This program is presented in a separate paper.)
 - 2. Uniform methods of herd analysis for use in the various states. (This program is presented in a separate paper.)
 - 3. Establish a permanent record system to coordinate with that of the Division of Dairy Herd Improvement Investigations of the Bureau of Dairy Industry.

4. Pedigree service based on proved sire data and Dairy Herd Improvement Association Records. Standard recommendations concerning material to be included in pedigrees are presented.
5. Establish a standard procedure for reporting environmental conditions at least once a year for all Dairy Herd Improvement Association herds.

E8. Dairy Herd Analysis and Proved Sire Work. E. H. LOVELAND, Vermont College of Agriculture, AND R. G. CONNELLY, Virginia College of Agriculture.

Very few states have undertaken any method of long-time analysis of the breeding of herds in dairy herd improvement associations. The value of work of this type has been made readily apparent with the search for superior germ plasm undertaken in 1935 by the Bureau of Dairy Industry. The problem is to devise a system through which dairy herd improvement association figures can be studied and used by herd owners in improving the germ plasm of their herds for production factors. Some of the requirements of such a system are:

1. Reasonable accuracy.
2. Simplicity.
3. Uniformity through the country.
4. Elasticity to allow for environmental conditions and revision.
5. Continuity over a period of years, past and future.

The system concerns itself with four phases—

1. The gathering of data.
2. Permanent records.
3. Analysis of records.
4. Follow-up of analysis.

The newly organized national proved sire program and the permanent life history sheets for cows and herd sires, together with the figures obtained in the superior germ plasm study, furnish a system of gathering and making permanent records obtained. For analysis, the following three forms are recommended:

1. A form presenting the sires used in chronological order in the herd at the top of sheet, with tabulated data as to production of daughters tested, comparison with dams, and numerical difference between daughter-dam records. In the vertical columns are presented the records of daughters of each bull arranged so that a cow family can be followed through horizontally on the sheet. The quality of the record will be indicated by color comparing production with both sire and dam. From this record superior lines of both male and female germ plasm can be located and traced through succeeding generations.

2. A line chart presenting the effect of herd sires used in chronological order by averages and range of production of dams and their daughters.

3. An arrow chart for bulls on which a more detailed study is desired showing the position of production of daughters relative to that of dams.

The first chart presents the herd as a whole, its progress and location of superior cow families. The second chart presents the herd sires used and effect on both average production and range of production for either milk, test or fat, as desired. The third chart gives opportunity for more detailed study of a particular bull for desired characters.

Forms from these charts should be prepared by the Bureau of Dairy Industry for national use. The preparation of these charts should be local within the state to give opportunity for variations to meet local conditions.

Such a system should be capable of revision as experience and development makes possible, but is a foundation for a permanent system of herd analysis which, if used by breeders as a basis for selection of breeding stock, especially herd sires, will add greatly to the value of dairy herd improvement association work as a tool for genetic improvement of our dairy cattle.

The states should institute plans of following up of these analyses through breeding schools, bull associations, publicity of superior germ plasm, and other extension methods designed to acquaint dairymen with these records, what they mean, and how they can be used.

E9. Alfalfa-Molasses Silage vs. Alfalfa Hay as a Roughage for Lactating Dairy Cows. RUSSELL E. HORWOOD, Upper Peninsula Sub-Station, Michigan State College.

Second cutting alfalfa, ensiled with molasses, was compared with second cutting alfalfa hay, field cured, as the sole roughage for cows in milk, in a 105-day feeding trial.

The alfalfa was cut September 23rd and 24th in the one-tenth bloom stage. Little wilting occurred due to cloudy weather. Thirty pounds of molasses diluted with three parts of water was added to each ton of chopped alfalfa silage at the bottom of the filler pipe. Twenty-three and one-half tons were placed in the silo in this manner.

In addition, two tons of unchopped alfalfa hay with molasses sprinkled over it were placed in the silo near the bottom. This was found to be even more palatable than the chopped silage. Three samples of the unchopped silage averaged 14.3 per cent grass.

The two tons of unchopped silage when packed was 12 inches in depth in the 14-foot diameter silo. Two tons of chopped silage immediately below the unchopped was 10 inches in depth.

Nine and one-half tons of alfalfa were cut at the same time and cured in the cock. This resulted in good quality hay which was fed against the alfalfa silage. Due to a lack of barn room some of this hay was fed to the main herd. This caused a shortage for the experiment, making it neces-

sary to use first cutting alfalfa of only fair quality during the last 30-day feeding period.

Four feet of spoilage was found on the surface when the silo was opened November 17th. Below this the silage was dark green in color. The temperature at the surface on November 30th was 39 degrees Fahrenheit; eight inches below the surface it was 59 degrees F., sixteen inches below 68 degrees F., and thirty-four inches below 68 degrees Fahrenheit.

Two groups of three cows each were placed on a feeding trial. The double reversal feeding system was followed using three thirty-day feeding periods with five days between each period.

One group of cows was fed 30 pounds of field cured hay, while the other group received 87 pounds of alfalfa-molasses silage per day. Each group received ground barley plus one per cent special odorless steamed bone meal and one per cent iodized salt at the following rates:

Below 20 lbs. milk— no grain	50 to 55 lbs. milk—14 lbs. grain
20 to 25 lbs. milk— 2 lbs. grain	55 to 60 " " —16 " "
25 to 30 " " — 4 " "	60 to 65 " " —18 " "
30 to 35 " " — 6 " "	65 to 70 " " —20 " "
35 to 40 " " — 8 " "	70 to 75 " " —22 " "
40 to 45 " " —10 " "	75 to 80 " " —24 " "
45 to 50 " " —12 " "	

The silage ration produced 10,483.7 pounds of 4 per cent fat corrected milk,¹ while the hay ration produced 10,173.4 pounds.

The cows on the silage ration gained 178 pounds in body weight while the cows on the hay ration gained 224 pounds during the feeding trial.

The cows on the silage ration consumed 23,490 pounds of silage and 2,950 pounds of grain. The cows on the hay ration consumed 8,100 pounds of hay and 3,105 pounds of grain.

Analysis at the start of the feeding trial showed that the silage contained 27.7 per cent dry matter and 21 per cent protein on a dry matter basis. The hay contained 86.4 per cent dry matter and 19.5 per cent protein on a dry matter basis.

Two analyses² of the silage for carotene content showed 24 and 21.6 gamma per gram on an air dry basis. The carotene content of two samples of butterfat produced during two different periods from the silage fed cows contained 1.5 and 0.8 mg. per kg. Two similar samples of butterfat from the hay fed cows contained 1.45 and 1.3 mg. per kg.

E10. Calf Starters Fed Dry with Limited Whole Milk. E. S. SAVAGE, Cornell University.

Bulletin 622 of the Cornell University Experiment Station, Ithaca, New York, gives the detailed work done with 76 calves on calf starters. As a

¹ Gaines & Davidson, Ill. Exp. Sta. Bul. 245.

² Courtesy of Dr. W. E. Krauss, Ohio Agricultural Exp. Station.

result of this work it is recommended that calves be limited to a total of 350 pounds of whole milk fed during the first seven weeks after birth. They are completely weaned from milk at seven weeks.

As soon as they will eat it they are fed all they will eat of good mixed hay with some legume in it, preferably second cutting mixed timothy and clover. In addition to the hay, as soon as they will eat it, (at about two weeks of age), they are offered all they will eat of the following mixture:

32.25	per cent	ground yellow corn
28.00	" "	rolled oats
10.00	" "	wheat bran
5.00	" "	linseed meal
3.00	" "	white fish meal
20.00	" "	dry skimmilk
0.50	" "	salt
0.50	" "	ground limestone
0.50	" "	steamed bone meal
0.25	" "	reinforced cod liver oil

This calf starter is fed dry in a box nailed up in the pen. A good sized box for four or five calves is 4' long, 4" high, and 4" wide. The calves are full fed free choice on this mixture until they consume four pounds per day.

When the calves are about 14 weeks old they are offered some fitting ration similar to the following:

560	lbs.	corn meal or hominy
600	"	wheat bran
600	"	ground oats
200	"	linseed oil meal
20	"	steamed bone meal
20	"	salt

The calves receive no calf starter after 16 weeks. Beginning with the 17th week they get only hay, fitting ration and water. All calves have free access to water after about the 3d week. They are restricted to 4 lbs. of fitting ration per day per calf.

Since Bulletin 622 was published sixteen calves have finished a six months' trial on the same calf starter as given above. Four were fed as a check lot. Four were fed on the same mixture in pellet form, four received the same mixture in pellet form with ground oats in place of the rolled oats, and four were fed the same mixture in pellet form with ground oats in place of rolled oats, and 200 pounds of alfalfa leaf meal instead of the same amount of corn and oats.

All calves on this calf starter and these modifications have been very thrifty and have made average gains to six months of age of 1.5 pounds per day or better.

No advantage has been obtained from feeding this starter in pellet form. Pelleting makes the feed a little cleaner to handle but the calves do not seem to eat the pellets any more freely or to gain any better on them.

Other trials are in progress studying the effect of yeast in different forms. A more concentrated starter is being studied in order to get the calves to eat more at the critical period at seven and eight weeks of age.

E11. Sudan Grass and Sweet Clover as Temporary Pasture Crops.

R. A. ACKERMAN AND H. O. HENDERSON, West Virginia University.

Bluegrass pasture usually gives excellent results in the early spring when it is lush and tender, but as the season advances it ripens and dies so that it is usually necessary to supplement it with some other pasture or green feed.

At the Reymann Memorial Farms, a study has been started to determine what crops are best to use at this time. The study has thus far included sudan grass with soybeans, and sweet clover seeded with oats, and they have been compared with a good bluegrass pasture. The plots contain two acres, are run in duplicate, and are fertilized at the same rate.

Dairy cows in milk were pastured on them in numbers sufficient to keep the growth at proper height. Measurements were made by the number of pasture days, the production of milk and butterfat, and the total amount of digestible protein and total digestible nutrients produced. The time at which the pasture was available for use was also calculated in order to determine the supplementary effect of pasture.

The following table shows the average number of pasture days furnished by each pasture over a period of three years, 1933-35 inclusive, and the percentage of the pasture which was furnished before August 1 and that furnished after August 1.

PASTURE	PASTURE DAYS PER ACRE	PER CENT FURNISHED BEFORE AUG. 1	PER CENT FURNISHED AFTER AUG. 1
Bluegrass	138.9	56.3	43.7
Sudan grass (and soybeans)	95.3	.7	99.3
1st yr. sweet clover and oats	42.8	49.8	50.2
2nd yr. sweet clover	132.2	100.0	0

It will be noted that while second year sweet clover furnished almost as many pasture days as did bluegrass, it furnished them all during the months when they are least needed. The first year sweet clover furnished very few days during the season, about one-half of which was furnished by the oats with which it was seeded. Sudan grass, on the other hand, while it did not furnish quite as many pasture days as did second-year sweet clover, supplied them in the season of the year when they were most useful for supplementing the blue grass.

E12. Summer Decline in Milk Production. H. O. WALES, JAS W. LINN, AND F. W. ATKESON, Kansas State College.

A lack of normal production and a refusal of milking herds to respond to apparently normal feeds and feeding practices, in the fall of 1935, prompted a study of the Dairy Herd Improvement Association monthly summaries to determine how the level of production for this season compared with that of previous years. This study emphasized to the authors the decided decline in summer production that was being obtained on the Kansas dairy farms. Tabulations were made over a period of six years, from 1930 to 1935 inclusive, on over 5,000 cows. Curves and tables are presented, showing trends of monthly production of milk and butterfat, butterfat price per pound and feed costs. The study shows a rapid increase in production in the spring months and a more rapid decline during the summer months. The peak of production usually comes in May, and the low point in September. The lowered production in the late summer months has resulted in a higher cost of milk production throughout a greater portion of the year, and is a tremendous loss to the industry.

It is not the purpose of this paper to outline the contributing causes of the summer slump, but rather to call attention to its significance in Kansas. This situation is also probably true throughout most of the middle western states and is an important problem associated with dairy herd management.

E13. Feeding More Roughage to Dairy Cows. C. F. HUFFMAN, Michigan State College.

The trend is toward greater utilization of pasture and roughage. Roughage usually refers to feeds high in lignocellulose which are low in digestibility. According to this definition young grasses which are high in productive energy on a dry basis are not roughages.

The feeding value of roughages depends on the stage of maturity, method of preservation, palatability and phosphorus content.

The first deficiency of a ration of alfalfa hay alone is productive energy. Experiments indicate that such a ration can produce about 150 pounds of butterfat per 305 day lactation. The addition of cereal grains to such a ration to meet the energy requirement results in the production of 400 to 500 pounds of butterfat per year. When alfalfa hay is worth \$6.00 per ton and corn is \$30.00 per ton the feed cost per pound of butterfat is about the same at various levels of production. When corn is fed and is worth less than \$30.00 per ton, the feed cost per pound of butterfat is less at higher levels of production than at low level of production when alfalfa alone is fed.

In regions where the phosphorus content of alfalfa hay is below 0.2 per cent, the home grown ration should be supplemented with a phosphorus supplement.

Suggestions for feeding alfalfa hay, corn silage and cereal grains:

Feeding Schedule for 1200 lb. Holstein

MILK PER DAY LBS.	ALFALFA HAY LBS.	SILAGE LBS.	LBS. CORN	BONE MEAL OZ.
20 lbs. or less	12	55		
25	14	50	2	
30	16	45	4	2
35	18	40	5	2
40	20	35	7	2
45	24	25	9	2
50	25	20	10	3
55	28	10	12	3
60	30		15	4

Feeding Schedule for 1000 lb. Jersey or Guernsey

MILK PER DAY LBS.	ALFALFA HAY LBS.	SILAGE LBS.	CORN LBS.	BONE MEAL OZ.
12	12	45	0	0
15	15	35	1 0	0
20	15	35	3.0	0
25	15	35	5.0	0
30	16	30	8 0	2
35	16	25	11.5	2
40	20	15	12.5	3
45	20	15	15.0	3
50	24		18.5	3

This system of feeding roughage and grain makes possible the efficient use of alfalfa, corn silage and corn. This system would probably work with a mixed hay of alfalfa and grass in place of straight alfalfa.

E14. 4-H Dairy Club Work as a Dairy Extension Project. JOE NAGOTTE, Pennsylvania State College.

The primary aim of 4-H dairy club work is to help farm boys and girls develop dairy herds, to instruct them in the most up to date methods of breeding, developing, and managing these herds, and especially to help them build broader, happier and fuller lives. In addition we dairymen can help develop the above program and bring about as many improved practices as any other dairy project if we put the same amount of energy and thought into it.

To aid in reaching the primary goal and to further increase the adoption of improved dairy practices, we make the following suggestions relative to the subject matter phase of the work:

1. The organizational and recreational responsibilities of the program should be assumed wholly by the club departments. The club and dairy departments should assume jointly the responsibilities of, promotion, con-

tests, and personal contacts. Calf standards and the teaching of subject matter should be assumed wholly by the dairy extension departments.

2. A dairy extension worker should explain the 4-H dairy project, its plan, and the possible results at a preliminary meeting of prospective club members and their parents.

3. All calves and home herds should be shown by tests or certification to be free of Bang's Disease and tuberculosis before the project is started.

4. All calves being used should be approved by a dairy extension worker. All calves should measure up to or exceed a definite State standard for apparent inheritance for production, and the calves should be suitable representatives of their breed as to type.

5. The project should be carried on for at least three years.

6. Suitable subject matter instruction should be prepared, and if possible presented by the dairy extension workers. This subject matter should be so timed that club members can apply this instruction to their calves.

7. An opportunity should be given to every club member to show his calf at a community round-up where the club members are scored on how well they have applied the instructions given them. The best exhibits from these community shows should be taken to a county or regional show and the best from these to a State show.

8. All dairy club contests should be so conducted that they will be a measure of how effectively the instructions can be applied by the club member.

9. Personal visits should follow if the club members and their parents wish to apply new practices to the home herd and if such visits are necessary for a successful application. It must be remembered that every club project is looked on by the community as a result demonstration.

10. In all cases, the dairy extension department should act as an advisor and not as a dictator. This work is educational and not regulatory.

11. Parents should be urged to attend all meetings where subject matter instructions are given.

12. The ground work should be laid so that as the club members mature, they would take up the adult dairy extension projects.

E15. 4-H Club Junior Bull Rings. M. L. FLACK, University of Nebraska.

It is an established fact that a great many farm boys and girls are enrolled every year in pure-bred animal projects but only a few of them ever develop pure-bred herds of improved types of live stock. The main reason for this is, that although a boy begins his club work with a good pure-bred female, no provision is made for him to mate her with a male of suitable quality. Often, the only pure-bred animal on the farm is the boy's club heifer and obviously it would not pay to own a pure-bred bull. Unless a farmer is interested in dairying and making that his major enterprise, he

does not care to keep on the farm a good dairy bull and certainly he does not care to invest a lot of money in a sire of the desired type and production. So it follows that many of the club members have had to use inferior bulls to which they breed their pure-bred heifers.

This condition of affairs is more serious in the middlewest than it is farther east because here greater numbers of farmers have herds that are greatly mixed or just fair to common grades. In some counties only a few men have pure-bred herds. Often in Nebraska 4-H Club boys and girls are great distances from owners of sires equally as good or better than the club cows.

A good farmer when planning the development of a pure-bred dairy herd, places the greatest emphasis upon the selection of a sire, which is the correct thing to do since a good sire is half the herd. This being the rule with adults, why should it not also apply to 4-H Club members who are going to be our breeders in the near future.

In order to change this existing condition in pure-bred dairy club work, the extension dairymen working with several of the county agents in 1932 developed a plan which partly provides for the lack of suitable sires. With this apparent need in mind, several 4-H Junior Bull Rings were organized in various counties in Nebraska under the supervision of the county agents, the extension dairymen, and advisory committee composed of the club members' parents. By means of these rings the services of bulls of better type and from higher producing ancestry are made available to both past and present 4-H Club members.

The rings are divided into blocks; a bull placed in each block so that every member will be within reasonable distance of a bull.

The bulls are purchased and owned cooperatively by the members. In order to save money, the bulls now in use were purchased as calves and grown out by the members.

It is required that the bulls be of superior conformation, free of disease and from high producing ancestry from dams producing not less than 500 pounds butter fat at maturity. All bulls must be approved by the state dairy extension specialist.

Aside from the assessment for the purchase of bulls, each member pays a membership fee. This money is used for moving bulls, paying veterinary bills, and other expenses arising in such an organization. In case a member wishes to withdraw he is paid a reasonable compensation for his investment in the bulls.

The success of such an organization depends largely upon the care and management of the bulls. So in order to safeguard the investments of the members the following rules and regulations have been found necessary.

1. The board of directors shall designate the places for keeping the bulls and arrange in each block a suitable bull pen and equipment necessary for

the safety of the keeper and for the health of the bull. All bulls shall be ringed. Each block director shall see to it that the bull in his territory is getting the correct kind of feed and the kind of care that will keep him in a strong, vigorous, healthy condition.

2. The bull shall not be permitted to run with the herd.

3. The bull shall not be allowed loose with any cow and shall not serve over two cows in one day, nor more than seven in a week.

4. The herd where bull is kept must be free of tuberculosis and Bang's disease.

5. All bulls must be purchased subject to the T. B. and Bang's test.

6. The custodian in return for care and feed shall have free service for his herd.

7. A nominal service fee shall be charged non-members of the club. No outside cows may be bred without permission of the board of directors.

8. The club bulls shall be inspected at least twice a year by a committee appointed by the directors and a report made as to their health, condition, and breeding ability.

9. No bull may be sold or disposed of without the consent of the board of directors, advisory committee, dairy specialist and county agent.

10. In case any bull is not receiving proper care and management, he shall be moved to a more desirable location by the board of directors.

11. A bull may be bought as a calf but shall not be used for service until he is one year old.

12. Every two years the bull in each block shall be shifted in the numerical order of the blocks, unless otherwise arranged. The directors shall arrange for the disposition of the bulls which have made a complete round of all the blocks.

In order to retain interest in the rings after they are well started, it has been found advisable to plan all-day tours, which include picnic dinners. One tour was for the purpose of dehorning all bulls, another was held in order to ring all bulls.

The county fair boards cooperate by providing a class for these bulls at the local county fairs with suitable prizes—a good way to add community interest in the project. Too, there is a place provided for them as a cooperative exhibit at the fairs. The Junior Sire Contest which parallels the Pure-bred Sire Contest stimulates interest.

One may readily realize that it is possible for these sire rings to become rather large organizations, since in Hamilton County the fourteen bulls are being used in approximately forty herds. The herds here are rather small and it is not practical for individual farmers to own bulls. Although time does not yet permit comparisons of production in offspring, yet there is a very marked improvement in the type.

E16. Dairy Projects for Older Boys. EARL N. SHULTZ, Iowa State College.

Census figures for 1930 showed that there were 3,000,000 more people on farms in the United States than there would have been under normal conditions. Approximately 2,000,000 of this number were young people between the ages of 16 and 25 years. This increase in rural population has continued up to 1935.

This increase has been due to the lack of employment in cities and because many farm young people have been unable to go to college. These young folks need and desire further educational opportunities.

Recently in a number of states rural young people have formed community and county-wide organizations for educational and recreational purposes. Extension workers have taken steps to plan projects for these young folks who are out of school and are reaching the upper age limits of 4-H Club work.

A study was made of the various dairy projects carried on by a number of states for older boys. A wide variety of projects were found. New Hampshire, California, and the province of Ontario, Canada, have divided the club work at 15 years. Boys above this age must carry more advanced type of work than those younger. Kentucky has formed Utopia clubs for rural young people 19 to 26 years of age. Members are elected to the clubs and must carry on one or more projects. The dairy project requires the maintenance of a dairy herd of not less than five females, the growing of alfalfa, conducting a pasture demonstration and the keeping of monthly feed and milk production records.

Minnesota has developed a farm partnership plan whereby father and son make a partnership agreement giving the son a share of the farm income. Nebraska has a junior bull ring plan for older boys who have developed small herds through club work. Iowa has given training to older boys to prepare them for leaders of local clubs.

The study of these plans and the comments of specialists working with them can be summarized as follows:

1. The project should not take from the father's income but should supplement the income from the farm.

2. It should be broad, including instruction in the historic and economic phases.

3. There should be actual work on a specific project as learning comes through activity.

4. The project should develop group action.

5. The project should cover a long period of time, from 3 to 5 years preferably.

6. Competitive features should be avoided but some form of recognition should be given.

7. Emphasis should be put on training in management and finance.

A project is outlined which will be carried out in Iowa during the coming year.

ABSTRACT

E17. The 4-H Classification at the National Dairy Show. D. M. SEATH,
Kansas State College.

Special recognition by the National Dairy Show of outstanding 4-H dairy cows is in prospect in the near future. Whenever classes are provided for 4-H animals it will be for cows in production according to the management of the show. Inasmuch as this year's show will be held at Dallas, Texas, which is relatively uncentral in location, such classes will not be included this year, however.

Dairy judging and demonstration contests will comprise the major 4-H activities at this year's National Dairy Show. For the first time Brown Swiss cattle will be judged in the junior contest. In each of the Ayrshire, Guernsey, Holstein, Jersey, and Brown Swiss breeds there shall be one ring of cows and one ring of heifers.

An additional demonstration team from each state will be eligible to compete in the demonstration contest according to a new plan inaugurated this year. This will allow each state to enter a team in each of the following classes: A—On production; B—On consumption; C—On manufacturing.

A significant change was made in the eligibility rule pertaining to winners of previous trips. As it now stands a 4-H member could represent his state on a demonstration team one year and still be eligible to represent his state on a judging team the next year. Likewise competition on a 4-H judging team would not bar him from future participation at the National Dairy Show on a demonstration team.

Additional money has been allowed to the committee in charge of the 4-H department of the National Dairy Show for conducting their department in 1936. Rules for the various contests and the plan for assisting in defraying expenses of contestants on an equitable basis will be outlined in the premium book. Advance copies of these plans either have been sent or will be sent within a short time to all of the state 4-H Club leaders. The writer represented the Extension Section of the American Dairy Science Association on the committee that drew up this year's plans.

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THE COMPOSITION AND APPARENT DIGESTIBILITY OF THE FLAT PEA (*LATHYRUS SILVESTRUS WAGNERI*)¹

R. E. HODGSON AND J. C. KNOTT

*Bureau of Dairy Industry, United States Department of Agriculture and Western
Washington Experiment Station, Puyallup, and Washington
Agricultural Experiment Station, Pullman²*

INTRODUCTION

The production of an abundance of palatable, nutritious forage is essential to economical milk production. High yielding pastures usually produce the cheapest feed nutrients. In general, hilly, upland pastures are rather unproductive and unfortunately constitute the major portion of the pasture area of Western Washington. Much can be done to increase the yield of such pastures by intensive pasture management and by introducing new plant species to replace the native low yielding forages. Untried crops that produce a large growth, that are permanent in nature, deep rooted and drought resistant deserve consideration for this purpose.

One such crop which has many desirable characteristics is the Flat Pea (*Lathyrus silvestrus Wagneri*). This crop is being considered for use as pasture in the upland districts of Western Washington.

The literature contains little information on the value of the Flat Pea as a crop. The available information is effectively summarized by Piper (1). He reports high yields, difficulty in securing a stand, conflicting opinions on palatability, and indicates its place among our forage crops as follows:

"The Flat Pea has nowhere in America attained any definite status as a field crop, but where a long-lived perennial legume is needed in the Northern States probably no other species is better adapted to the purpose."

This paper is a report of the composition and apparent digestibility of Flat Pea forage.

EXPERIMENTAL

The Flat Pea forage used in this experiment was secured from a field near Ashford, Washington. This field, located on a mountain side, was

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² The writers are indebted to Mr. Vernon Miller who conducted the analytical work involved in this investigation.

seeded over 30 years ago. The stand has resisted infestation with weeds and brush to a marked degree and appears to be spreading slowly. Cattle have grazed on this field to some extent. The forage was cut on August 24, 1935, and cured in the sun. When cut the peas were in full bloom, some of the lower pods had seeds in them and the forage was from three to four feet high. The freshly cut forage had an average dry matter content of 22 per cent.

The apparent digestibility of the sun-cured Flat Pea was determined by feeding it as an exclusive ration to three wether lambs. The methods used in conducting the digestion trials were the same as that described by Hodgson and associates (2), following the procedure outlined by Forbes and Grindley (3).

A sufficient amount of the hay to last the entire trial was weighed out in individual feedings and stored in paper bags. The forage was carefully sampled for chemical analysis at the time the experimental rations were prepared.

The sheep were fed twice daily and all of the feed offered was consumed. At the end of the experimental day the feces were collected, thoroughly mixed, weighed, and 50 per cent of the daily excretion was saved for chemical analysis. The samples were collected and stored in a refrigerator at 14° F. At the close of the collection period the daily aliquots of feces of each sheep were mixed and sampled for chemical analysis. The analyses of the feeds and feces were made by the usual methods as outlined by the Association of Official Agricultural Chemists (4).

EXPERIMENTAL RESULTS

The results of the experiment are presented in two tables. Table 1 shows the percentage composition of the Flat Pea hay and of the feces excreted by each of the three sheep. In Table 2 are shown the amounts of dry matter and nutrients ingested, voided, digested, and the percentage digestibility. The results obtained on each of the three sheep are in close agreement. The average daily consumption of dry matter by the sheep amounted to 770 grams and at that intake they lost an average of one pound of live weight during the 21 day test period. After the sheep became accustomed to the feed they consumed it readily.

TABLE 1
Percentage composition of feed and feces (dry matter basis)

MATERIAL	DRY MATTER	CRUDE PROTEIN	CRUDE FIBER	ETHER EXTRACT	NITROGEN- FREE EXTRACT	ASH
Flat Pea hay	82.9	25.29	29.83	2.23	36.62	6.03
Feces-Sheep 1	42.5	14.35	43.06	3.09	31.83	7.67
Feces-Sheep 2	35.9	13.76	44.03	2.99	31.90	7.32
Feces-Sheep 3	40.5	13.36	44.00	3.01	32.53	7.10

TABLE 2

Dry matter and nutrients ingested, voided, and digested by sheep receiving a ration of flat pea hay

	DRY MATTER	CRUDE PROTEIN	CRUDE FIBER	ETHER EXTRACT	NITROGEN- FREE EXTRACT	ASH
Sheep I						
Fed, grams	9865.1	2494.9	2942.8	220.0	3612.6	594.9
Voided, grams	3795.3	544.6	1634.3	117.3	1208.0	291.1
Digested, grams	6069.8	1950.3	1308.3	102.7	2404.6	303.8
Digested, per cent	61.53	78.17	44.46	46.68	66.56	51.07
Sheep II						
Fed, grams	7875.5	1991.7	2349.3	175.6	2884.0	474.9
Voided, grams	3130.1	430.7	1378.2	93.6	998.5	229.1
Digested, grams	4745.4	1561.0	971.1	82.0	1885.5	245.8
Digested, per cent	60.25	78.37	41.34	46.70	65.38	51.76
Sheep III						
Fed, grams	11606.0	2935.2	3462.1	258.8	4250.1	699.8
Voided, grams	4740.9	633.4	2086.0	142.7	1542.2	336.6
Digested, grams	6865.1	2301.8	1376.1	116.1	2707.9	363.2
Digested, per cent	59.15	78.42	39.75	44.86	63.71	51.90
Average						
Fed, grams	9782.2	2473.9	2918.1	218.1	3582.2	589.9
Voided, grams	3888.8	536.2	1699.5	117.9	1216.2	285.6
Digested, grams	5185.4	1937.6	1218.5	100.3	2366.0	304.3
Digested, per cent	60.31	78.32	41.85	45.75	65.22	51.58

The average composition of the dry matter of the Flat Pea hay approximates that reported by Henry and Morrison (5). The material had a high protein content for forage harvested in the late bloom stage which was probably due to the leafy, weak stemmed nature of the plant. The fiber content is not unusually high for that type of forage.

An analysis of the data in Table 2 shows that the apparent digestibility of the various nutrients compares favorably with that of alfalfa and the commonly used clover hays. The protein digestibility was higher while the crude fiber and nitrogen-free extract was slightly lower.

SUMMARY

Digestion experiments with three wether lambs were conducted to determine the apparent digestibility of Flat Pea (*Lathyrus silvestris Wagneri*) hay.

The crude protein which constituted 25.3 per cent of the dry matter of the Flat Pea hay had an average digestibility coefficient of 78.3 per cent. The apparent digestibility of the crude fiber was 41.8 per cent; ether extract, 45.8 per cent; nitrogen-free extract, 65.2 per cent; and ash, 51.6 per cent.

On the basis of the composition and apparent digestibility as determined in this experiment, 100 pounds of dry matter would contain 19.7 pounds of digestible crude protein and 58.4 pounds of total digestible nutrients.

The results indicate that the Flat Pea forage is palatable and highly nutritious.

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THE BACTERIOLOGY OF SWISS CHEESE

V. THE USE OF *Streptococcus thermophilus* IN RIPENING MILK FOR SWISS CHEESE

W. C. FRAZIER,* H. F. LONG,** AND WM T. JOHNSON, JR.

Research Laboratories, Bureau of Dairy Industry, Washington, D. C.

The so-called "ripeness" of milk to be used in making Swiss cheese has been the subject of much study but cause and definition of ripeness are still unknown. The cheesemaker judges the ripeness of the milk by the way it acts in the kettle and in particular by what he calls the "grip" of the curd. The most commonly used method to estimate the state of ripeness of milk has been the methylene blue reduction test: a short reduction time has been taken to indicate a ripe milk. *Streptococcus lactis* or similar organisms have been considered the most active in ripening milk and when milk is held to develop ripeness, conditions are usually such as to favor this type of organism.

As early as 1906, however, Orla-Jensen (3) thought that the ripening was probably not due to the ordinary *Str. lactis* but to a lactic streptococcus which could grow at temperatures as high as 48° C. and which did not grow at temperatures below 20° C. He said that keeping the night's milk warm favored this organism and helped ripening. This organism was undoubtedly of the *Str. thermophilus* type. It has often been observed that if a cheesemaker sends back whey in the cans in which his patrons brought the milk that the milk on following days is riper than when the whey is sent back in different cans. This whey ordinarily contains only lactobacilli which would grow to a limited extent in milk at the temperatures at which it is usually held and *Str. thermophilus* which will grow at temperatures as low as 20° C.

It is rather difficult to control ripening of milk when the milk is held over either with or without inoculation with lactic streptococci. There is always the possibility of the growth of gas organisms or too much growth of lactic bacteria. It was thought that if *Str. thermophilus* could be used for ripening that this organism might be grown in milk at such a high temperature that most other bacteria could not grow, and that ripening might be accomplished in a short time under controlled conditions. Experiments were conducted at Washington, D. C., with small cheeses of 50-55 pounds, green weight, and at the Grove City Creamery, Grove City, Pa., with large cheeses of 155-160 pounds, green weight. Methods of sampling and examination were as described in paper No. II (1) of this series.

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EXPERIMENTAL

In the experiments at Washington attempts were made at first to ripen the milk over night with *Str. thermophilus* (C₁ strain) at from 20° to 25° C. In a few experiments some of the milk was pasteurized, cooled and inoculated with C₃. In all experiments in which part of the milk was inoculated with C₃ and held over night the resulting cheeses were No. 2 grade while the control cheeses were better. Similar results were obtained with over night ripening after inoculation with *Str. lactis*. The addition of *Str. lactis* to the first portion of milk into the cheese kettle also gave unsatisfactory results.

In other experiments part of the milk, usually about one-fifth of the total amount to be used in the kettle, was heated to 48 to 50° C., inoculated with one-fourth per cent of a milk culture of C₁, held to temperature for a period varying from 30 minutes to an hour and 135 minutes in different experiments, and then cooled by mixing the heated milk with the remainder of the milk in the cheese kettle.

The results of parallel experiments on ripening milk with C₁ for the manufacture of small cheeses at Washington are shown in table 1. It will

TABLE 1
Comparison of small cheeses made with and without ripening with *Str. thermophilus* (C₁)

CHEESE NO	C ₁ RIPENING		GRADE	SCORE	REMARKS
	Time	Temp			
1405-1	80	48	Poor No. 1	78.75	Less checking, better eyes
1405			Fair No. 1	82.50	
1447-1	60	50	No. 2	68.0	Less checking and glass
1447			Special	77.0	
1422-1	69	50	Poor No. 1	78.5	Less checking
1422			Fair No. 1	80.0	
1449-1	75	50	Fair No. 1	82.0	Better eyes, less glass
1449			No. 2	69.0	
1428-1	80	50	Poor No. 1	77.5	Less checking
1428			Poor No. 1	79.0	
1409-1	96	50	Special	73.5	Eyes slightly better
1409			Special	71	
1424-1	135	50-52	Fair No. 1	81.5	Better eyes, less checking
1424			Special	73.5	

be noted that ripening part of the milk for a short period improved the quality of the cheese, while ripening for 75 minutes or over either did not improve or else harmed the quality of the cheese. Part of the milk for cheese No. 1405 was ripened at 48° C., instead of 50°, and for 80 minutes with a resulting improvement in the quality of the cheese.

The growth of *Str. thermophilus* (C_1) in the kettle and the first hours in the press in a pair of cheeses is shown in table 2. Part of the milk in the

TABLE 2
Growth of Str. thermophilus (C_1) in cheese with and without " C_2 ripening"

SAMPLE	CONTROL CHEESE NOS. OF C_1 PER CC. OR GM.	CHEESE WITH C_2 RIPENING NOS. OF C_1 PER CC. OR GM.
Kettle milk	3,130,000	6,720,000
Before cooking	5,740,000	37,900,000
Before dipping	8,890,000	44,700,000
1 hr. after dipping	48,500,000	81,500,000
3 hrs. " "	42,800,000	109,000,000
5 " " "	91,200,000	98,900,000
8 " " "	202,000,000	93,000,000

test cheese had been ripened with C_2 at 50° C. and none of the milk in the control cheese had been ripened. The C_1 coccus is shown to be especially active in the kettle and to grow to a limited extent in the cheese in the press when part of the milk had been ripened with C_2 . In the control cheese there was a gradual increase in numbers of C_1 organisms in the kettle contents and after the cheese had been on the press for three hours. In both cheeses the increase in numbers after dipping is due to concentration of the bacteria in the curd and not to growth. Similar results obtained with other pairs of cheese indicated that most of the *Str. thermophilus* organisms added by ripening part of the milk grew only in the kettle and showed little or no increase in numbers after the first few hours in the press. For this reason a *Str. thermophilus* starter was added, even when part of the milk had been ripened with C_2 , so that growth would take place in the cheese in the press.

Ripening part of the milk with *Str. thermophilus* was tried with a number of large wheels of Swiss cheese made at Grove City. The results obtained appeared inconsistent until the ripeness of the milk as indicated by the methylene blue reduction time was considered. Table 3 shows how the

TABLE 3
Influence of ripeness of milk on success of C_2 ripening of milk for large cheeses (Grove City, Pa.)

REDUCTION TIME	NO. OF CHEESES	NO. 1 OR FANCY		SPECIAL		TOTAL CUTTABLE	NO. 2	
Hours		No.	Per cent	No.	Per cent	Per cent	No.	Per cent
Less than 5	16	7	43.75	6	37.50	81.25	3	18.75
5 or more	39	28	71.80	10	25.64	97.44	1	2.56
6 or more	25	18	72.00	7	28.00	100.00	0	0.0

success of ripening with C_2 was apparently dependent on the ripeness of the kettle milk. When the methylene blue reduction time was five hours or

over there was an apparent benefit from ripening with *Str. thermophilus*. For comparison results are given in table 4 of cheeses made during the same

TABLE 4
The relationship of the methylene blue reduction time of the milk to the quality of large cheeses made at Grove City, Pa.

REDUCTION TIME	NO. OF CHEESES	NO. 1 OR FANCY		SPECIAL		TOTAL CUTTABLE	NO. 2	
Hours		No.	Per cent	No.	Per cent	Per cent	No.	Per cent
Less than 5	10	7	70.00	2	20.00	90.00	1	10.00
5 or more	22	13	59.09	7	31.82	90.91	2	9.09

period without ripening. It will be observed that better cheeses resulted when the reduction time was less than 5 hours (it was never less than 3 hours) than when it was over 5 hours, and that the percentage of high grade cheeses made from unripened milk with a methylene blue reduction time of over five hours was lower than the percentage made from ripened milk, which, without ripening, had a reduction time of over five hours. A series of parallel experiments was conducted, in which the test cheeses were ripened with *C.*, but no usable results were obtained because during this period the methylene blue reduction time was consistently 5 hours or less.

An examination of the changes in pH of the interior of cheeses made with milk part of which had been ripened with *C.* shows, as would be expected, a more rapid drop in pH during the first few hours in the press than in control cheeses and a higher pH after 21 hours. The average pH of large cheeses made from milk ripened with the *C.* streptococcus was 6.35 at dipping (0 hours), 5.89 three hours after dipping, 5.69 eight hours after dipping, and 5.32 twenty-one hours after dipping. The corresponding pH values of control cheeses were 6.37, 6.13, 5.99 and 5.17, respectively. Thus the pH values of cheeses made with milk part of which had been ripened with *Str. thermophilus* are different from the pH values found best for cheese made from unripened milk as cited in a previous paper of this series (2).

DISCUSSION

As has been shown, ripening of part of the milk with *Str. thermophilus* is not advantageous unless the milk has a fairly long methylene blue reduction time. If the milk has a reduction time of five hours or less ripening with *Str. thermophilus* is not to be recommended. In practice the kettle milk at most Swiss cheese factories has a methylene blue reduction time or less than five hours during most of the year. During the winter, however, the reduction time may be longer. If the milk is being produced under carefully controlled conditions and is being cooled promptly to a low temperature it may have a long reduction time during most of the year. Then ripening with *Str. thermophilus* may be helpful.

SUMMARY

Attempts were made to ripen milk for Swiss cheese by inoculation with *Str. lactis* or *Str. thermophilus* and holding over night at 20 to 25° C. Inoculation of the kettle milk with *Str. lactis* was also attempted. About one-fifth of the milk to be used in making Swiss cheese was heated to 50° C., inoculated with *Str. thermophilus* and held for varying periods at that temperature before it was mixed with the rest of the milk for the cheese. Cheeses made with this milk were compared with cheeses made from untreated milk. The experiments led to the following conclusions:

1. Ripening milk by inoculating it with *Str. lactis* or *Str. thermophilus* and holding it over night at 20 to 25° C. did not produce satisfactory results, nor did the addition of *Str. lactis* to the kettle milk.

2. A temperature of 50° C. with a holding time of from 30 to 60 minutes has been satisfactory for ripening the milk with *Str. thermophilus*.

3. *Str. thermophilus* introduced into the kettle milk by addition of milk ripened with this organism increased in numbers to a greater extent in the kettle than did *Str. thermophilus* added as a starter, but grew slightly or not at all in the press.

4. Ripening with *Str. thermophilus* usually improved the quality of the cheese when the methylene blue reduction time of the kettle milk was 5 to 6 hours or longer, but was not helpful if the milk had a shorter reduction time.

5. pH values of the interior of the cheeses made with milk ripened with *Str. thermophilus* were lower in the early hours that the cheeses were in the press and higher after 21 hours in the press than the pH values of cheeses made with unripened milk.

6. Ripening part of the cheese milk with *Str. thermophilus* may be used to improve the quality of Swiss cheese when the kettle milk acts "dead," that is, the curd does not have the proper "grip" or consistency in the kettle.

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THE INFLUENCE OF METHOD OF STERILIZING EQUIPMENT UPON DEVELOPMENT OF OXIDIZED FLAVOR IN MILK*

A. C. DAHLBERG AND D. C. CARPENTER

New York Agricultural Experiment Station, Geneva, N. Y.

It is very probable that an effect of certain metals upon the flavor of milk was observed from the very beginning of the extensive use of metals for equipment at the close of the last century. Both tin and oak were recommended for dairy equipment from 1850 to 1875. Commencing about 1920 the effect of metals on flavor of milk has been subjected to numerous studies probably due to the development of new alloys and to marked improvement in the quality of milk products. Hunziker, Cordes, and Nissen (1) in their extensive investigations of metals in dairy equipment reported that copper and iron produced metallic flavors in sweet milk. Kende (2) was probably the first to establish that this flavor (metallic, cappy, cardboard, stale, or oxidized) might develop in milk not subjected to exposure to either iron or copper. The development of the oxidized flavor was accelerated by increased copper content of the milk, by pasteurization at 63° C. for 30 minutes, by very low bacterial counts, and by elimination of green feeds in the rations of the cows. Davis (3) found that the contamination of milk with copper was greatest in the first milk through the equipment and that such milk became oxidized in flavor. Tracy, Ramsey, and Ruehe (4) gave special attention to the oxidative nature of the change which produced the off-flavor and to the deleterious effect produced on the first milk through the equipment.

In 1932 it was noticed in our dairy operations that chlorine sterilization of equipment greatly accelerated the development of oxidized flavor when compared with hot water sterilization. It was believed that this effect was due to high copper contamination and experiments were planned to establish this relationship.

EXPERIMENTAL METHODS

Milk Production Methods—In these studies it was planned to have all conditions favorable to the development of the oxidized flavor except metal contamination. The experiments were conducted in January, February, and March when the cows were on winter feeds. Bacterial counts were held low by careful cleaning and sterilization of equipment used in the barn. Pails, cans, etc., were sterilized in a cabinet heated to 200° F. for 10 minutes

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and this cabinet also served as a drier. The milking machine rubber parts were sterilized with hot water at 165–170° F. for 2 minutes immediately after and just before use. No chlorine was employed for sterilizing any of the barn utensils.

Contact of the milk with all metals except aluminium was avoided until the milk reached the pasteurizing room. The milk passed through rubber tubes into aluminum pails. It was poured directly into aluminum cans which were placed in ice water for cooling the milk. The only contact with any other metals was a well tinned stop-cock in the milk line at the head of the milking machine pail.

In the pasteurizing room the milk was stirred in the aluminum cans and sampled for bacteriological analyses, for copper and iron determinations, and for flavor and keeping quality. It was then emptied into a 20-gallon well-tinned copper tank, pumped through a bronze rotary pump, through a filter into a 125-gallon spray vat pasteurizer lined with 18–8 alloy steel. The sanitary piping was nine feet in length and was an alloy of iron, nickel, and copper. After pasteurization at 143° F. for 30 minutes the milk passed through four feet of piping to a surface tubular cooler on which it was cooled below 40° F. before entering aluminum cans. The first 25 pounds of milk off the cooler were caught in a sterilized can, the next 25 pounds in another sterile can, then the next 50 pounds, then the next 100 pounds, then the next 100 pounds, and finally another 100 pounds. Samples were secured of each consecutive batch of pasteurized milk for analysis and flavor tests.

Sterilization Procedures—The principal objective of the investigation was to establish the relationship of the method of sterilization to the development of oxidized flavor. When hot water sterilization was employed, water at 165–170° F. was pumped through the pipe line into the pasteurizer and over the cooler for a period of 5 minutes just prior to use. Two methods were followed with chlorine sterilization. In the one instance 15 gallons of a chlorine solution with a sodium carbonate base, containing 100 parts per million of available chlorine were pumped through the equipment at 100° F. Immediately thereafter the milk was pumped into the pasteurizer. A period of nearly one hour elapsed before the hot milk began to flow over the cooler. In another series of tests the contact of the chlorine solution with the metal lasted for 5 minutes after which period water at 165–170° F. was pumped through the equipment with the thought that the action of chlorine on the metal would be stopped by the rinse. In all instances sterilization was accomplished just prior to use of the equipment.

Keeping Quality Tests—The cooled milk was promptly placed in sterilized pint glass bottles and stored at 34–40° F. At the end of one hour, and one, two, and three days a bottle of each sample was warmed to 80° F., scored independently by three judges, and discarded.

Bacteriological Methods—The bacterial content of the raw and pasteurized milks was estimated by the plate method and the methylene blue reduc-

tion test following Standard Methods. It was recognized that more accurate procedures might have been employed to estimate bacterial numbers but the methods employed were ample to establish the point under consideration, namely that the milk was of low bacterial content. Bacterial counts and methylene blue tests were made in duplicate on each sample of milk each time that it was scored for flavor.

The bacteriological data obtained are not presented in detail as they are negative and it is important in this study only to know that the count was very low. All samples of raw milk when fresh and after storage at 34–40° F. for one, two, and three days gave a standard plate count which varied from 1,200 to 8,000 with the majority of counts ranging from 2000 to 5000. The methylene blue reduction time of the fresh and aged raw milks varied from 11 to 25 hours with the majority of periods ranging from 18 to 22 hours. The bacterial counts of the fresh and aged pasteurized milks were nearly all below 100 and no count exceeded 250. The methylene blue reduction periods for the pasteurized milks varied from 15 to 30 hours with a majority of tests from 20 to 25 hours. These data clearly exclude bacteria as a cause or a preventative of the oxidized flavor.

ANALYSIS OF MILK FOR COPPER AND IRON

The difficulties in the determination of micro-quantities of copper and iron as usually present in milk have been recently reviewed by Conn, Johnson, Trebler and Karpenko (5). The analytical procedure which we have used was based largely on the method adopted by these workers with certain minor modifications, the chief one of which was the extraction of the colored copper diethyldithiocarbamate complex with iso-amyl alcohol previous to the comparison with a standard in the colorimeter. This procedure obviated the troublesome turbidity often encountered with aqueous solvents. Another modification was the precipitation of CuS from a normal HCl solution instead of a 1 per cent solution as used by the foregoing workers.

General Precautions—By no means the least important part of securing high accuracy in these determinations has been scrupulous cleanliness with regard to glass, platinum ware, etc. and protection from dust. Distilled water, hydrochloric acid and ammonia were redistilled in all glass equipment to render them copper and iron free. Other chemicals did not require purification beyond the usual analytical grade because of the fact that only small amounts were required in the analyses and a blank determination took care of this correction.

Preparation of Sample—Samples were withdrawn from well agitated milk and stored in stoppered glass Erlenmeyer flasks at 32–38° F. until such time as the analyses could be made. Samples were preserved with two drops of formalin solution added to 250–300 cc. of milk. The cream layer

was thoroughly dispersed in the milk by shaking after warming to 110–120° F. and 100 gm. samples removed for analysis and transferred to platinum evaporating dishes. All analyses were made in duplicate.

Evaporation and Ashing—To precipitate a large share of the protein and reduce foaming, 5 drops of glacial acetic acid were added to the sample which was evaporated to dryness on the electric hot plate. Sample was then ashed at a temperature not to exceed 560° C. in an electric muffle to give a whitish gray ash.

Solution of Ash and Reashing of Residue—To the cooled ash 4–5 cc. of 20 per cent HCl were added, the dish warmed on the hot plate to dissolve the ash and the solution transferred to a 15 cc. centrifuge tube with as little wash water as possible. The tube was centrifuged for 10 minutes at 1800 r.p.m. to throw down the small amount of unburned carbon and the solution transferred to a second centrifuge tube. The unburned carbon was rinsed into the platinum dish, evaporated to dryness and again ashed in the muffle. The residue was dissolved in 0.5 cc. of 20 per cent HCl and washed into the centrifuge tube containing the bulk of the sample. Twenty per cent NH_4OH solution was added drop by drop to the acid solution until a faint precipitate of CaHPO_4 was formed which remained after stirring with a fine glass rod. Sufficient HCl was then added to bring the acid concentration to normal strength.

Precipitation of CuS—The sample in the centrifuge tube was heated in a boiling water bath and saturated with H_2S gas through a fine capillary tube while cooling, the delivery tube being washed off with a few drops of normal HCl saturated with H_2S . The tube was stoppered and allowed to stand over night.

Centrifuging and Dissolving of CuS—After standing over night, the samples were centrifuged 30 minutes at 1800 r.p.m. The supernatant liquid was poured off and saved for the iron determination and the precipitated CuS was washed with 2 cc. of normal HCl saturated with H_2S and centrifuged 30 minutes and the wash solution added to that previously reserved for the iron determination. To the CuS which remained in the centrifuge tube 4–6 drops of fuming HNO_3 were added and the tube warmed in a boiling water bath for 10 minutes for solution to take place. The sample was then cooled, 5 cc. of water added and then made alkaline with 1 cc. of 20 per cent NH_4OH and washed into a separatory funnel with about 5 cc. of water.

Colorimetric Estimation of Copper—To the sample in the separatory funnel 1 cc. of a 0.1 per cent aqueous solution of sodium diethyldithiocarbamate was added and then exactly 10 cc. of iso-amyl alcohol and the funnel well shaken. The golden colored copper diethyldithiocarbamate complex was completely extracted from the aqueous layer by the amyl

alcohol and the latter was drawn off and compared in a colorimeter with a copper standard of about the same color intensity prepared in the same way from a standard CuSO_4 solution.

Colorimetric Estimation of Iron—The mother liquid from which the copper was precipitated by H_2S and the wash solution from washing the CuS was made up to 50 cc. in a volumetric flask. A 10 cc. aliquot of this was pipetted into a 150 cc. beaker, 5 cc. of 20% HCl added and the volume made up to 25 cc. after which the solution was boiled for 20 minutes, cooled, 1 drop of HNO_3 added and transferred to the separatory funnel where 1 cc. conc. HCl and sufficient $n/10$ KMnO_4 solution (1–2 drops) to give a pink color was added. Exactly 10 cc. of iso-amyl alcohol and 5 cc. of a 20 per cent KCNS solution were added to the contents of the funnel and the funnel shaken vigorously. The amyl alcohol layer containing the red $\text{Fe}(\text{CNS})_3$ was drawn off and compared with an iron standard prepared in the same way and of about the same color intensity. McFarlane (6) has shown that satisfactory color matches are secured on iso-amyl alcohol solutions containing 0.007–0.022 mg. Fe . Our results have fallen close to the lower limit of these figures and we have had no difficulty in color matches.

In Table 1 are given a series of analyses of milk in duplicate showing the precision attainable (usually within 2 per cent) by the method. On such small quantities of the metals concerned, this is extremely good duplication for any method involving colorimetry.

TABLE 1
Duplicability of copper and iron analyses of milks

SAMPLE NO	MG PER 1000 G. MILK			
	Cu found mg. (a)	Fe found mg. (a)	Mean Cu	Mean Fe
W 101	0.0171	0.0060	0.172	0.302
	0.0171	0.0061		
W 111	0.0866	0.0091	0.863	0.457
	0.0860	0.0092		
W 121	0.0246	0.0090	0.244	0.453
	0.0242	0.0091		
W 131	0.0229	0.0058	0.230	0.289
	0.0232	0.0058		
W 141	0.0226	0.0058	0.224	0.293
	0.0222	0.0059		

* Colorimetric determination for Cu carried out on residue from 100 g. milk and for Fe from 20 g. milk.

RESULTS

Hot Water Sterilization

The results secured from two series of experiments using hot water at 165–170° F. for sterilization of the pasteurization equipment are given in Table 2. The footnotes to Table 2 which summarize the bacterial counts and methylene blue reduction periods indicate a very low bacterial content which others have shown to be inducive to oxidized flavor. In the table each score on flavor is the average of three judges scoring independently.

TABLE 2
*Keeping quality and the copper and iron content of milk pasteurized and cooled
in equipment sterilized with hot water*

MILK SAMPLE		FLAVOR SCORES				MG. PER 1000 GM. MILK		
No.	Treatment	1 hour	1 day	2 day	3 day	Copper	Iron	Total
W 10	Raw	22.8	22.3	21.2	22.1	0.172	0.302	0.474
W 11	Past. 0–25 lbs.	23.0	22.5*	17.0*	17.5*	0.863	0.457	1.320
W 12	Past. 25–50 lbs.	23.0	23.0	21.0*	17.8*	0.244	0.453	0.697
W 13	Past. 50–100 lbs.	23.0	22.8	22.8	21.8	0.230	0.289	0.519
W 14	Past. 100–200 lbs.	23.0	23.0	22.8	22.3	0.224	0.293	0.517
W 15	Past. 200–300 lbs.	22.7	23.0	22.8	22.3			
W 16	Past. 300–400 lbs.	23.0	22.8	23.0	22.5			
W 20	Raw	22.4	22.2	22.8	22.2	0.104	0.324	0.428
W 21	Past. 0–25 lbs.	22.5	21.3*	19.8*	19.3*	0.223	0.345	0.568
W 22	Past. 25–50 lbs.	22.8	23.0	22.7	21.9*	0.157	0.325	0.482
W 23	Past. 50–100 lbs.	23.0	22.8	22.7	22.2*	0.146	0.319	0.465
W 24	Past. 100–200 lbs.	23.0	23.0	22.8	22.8	0.153	0.324	0.477
W 25	Past. 200–300 lbs.	23.0	23.0	22.8	22.7			
W 26	Past. 300–400 lbs.	23.0	23.0	22.8	22.8			

* Oxidized according to at least two of the three judges.

W 10—Plate count 2,300 to 7,200; methylene blue reduction time 11 to 16 hours; 5.1 per cent fat.

W 11–W 16—All plate counts were less than 100; methylene blue reduction time 17 to 22 hours.

W 20—Plate count 4,900 to 7,600; methylene blue reduction time 17 to 19 hours; 5.2 per cent fat.

W 21–W 26—All plate counts were less than 100; methylene blue reduction time 17 to 26 hours.

It will be noted that the raw milk and the hot milk which passed through the equipment after the first 50 pounds had been through, kept well for three days without the development of oxidized flavor. All samples of milk were of excellent flavor when one hour old. However, the first 25 pounds of milk through the equipment developed a trace of oxidized flavor in one day and was bad in two days. The second 25 pounds of milk through the equipment developed an oxidized flavor in two or in three days. It should

be borne in mind that the tendency of this milk to develop the oxidized flavor was accentuated by the passage through only four feet of piping and over a tubular cooler.

The iron and copper content of the milk markedly increased by exposure to the metal but the increase was very small after the first 50 pounds of milk had passed over the cooler.

It is evident that removal of the first 25 pounds of milk from the milk supply would have materially reduced the copper and iron content of the remainder of the milk and the tendency to become oxidized. The first 25 pounds of milk through the equipment had a copper and iron content of 1.32 parts per million. After 100 pounds of milk had been cooled the copper and iron content of the milk was practically identical with that of the raw milk that had never come in contact with these metals. Apparently the cold milk did not remove appreciable amounts of these metals from the finned copper, bronze, alloy, and 18-8 stainless steel with which it came in contact for 15 to 30 minutes.

TABLE 3

Keeping quality and the copper and iron content of milk pasteurized and cooled in equipment sterilized with a chlorine solution

MILK SAMPLE		FLAVOR SCORES				MG PER 1000 GM MILK		
No	Treatment	1 hour	1 day	2 day	3 day	Copper	Iron	Total
C 10	Raw	22.0	21.8	22.2	20.8	0.155	0.456	0.611
C 11	Past. 0-25 lbs.	19.5**	17.3*	15.3*	15.3*	0.335	0.675	1.010
C 12	Past. 25-50 lbs.	21.8	22.1	17.3*	16.6*	0.313	0.550	0.863
C 13	Past. 50-100 lbs.	23.3	22.5	21.2	16.6*	0.245	0.537	0.882
C 14	Past. 100-200 lbs.	23.3	22.8	22.5	19.0*	0.203	0.537	0.740
C 15	Past. 200-300 lbs.	23.3	22.5	22.0	18.7*			
C 16	Past. 300-400 lbs.	23.5	22.8	22.2	20.8*			
C 20	Raw	22.8	21.8	21.5	21.2	0.096	0.363	0.459
C 21	Past. 0-25 lbs.	21.0**	16.8*	17.6*	14.3*	0.177	0.451	0.628
C 22	Past. 25-50 lbs.	22.7	22.2*	20.7*	20.2*	0.155	0.369	0.524
C 23	Past. 50-100 lbs.	23.5	22.3	21.0	21.1*	0.137	0.370	0.507
C 24	Past. 100-200 lbs.	23.5	22.8	22.0	21.5	0.121	0.366	0.487
C 25	Past. 200-300 lbs.	23.0	22.8	22.0	21.3			
C 26	Past. 300-400 lbs.	23.3	22.5	22.0	21.8			

* Oxidized according to at least two of the three judges.

** Medicinal or antiseptic (coal tar flavor).

C 10—Plate count 2,000 to 2,800; methylene blue reduction time 18 to 23 hours; 4.85 per cent fat.

C 11-C 16—All plate counts were less than 100; methylene blue reduction time 21 to 30 hours.

C 20—Plate count 2,500 to 3,500; methylene blue reduction time 18 to 23 hours; 5.65 per cent fat.

C 21-C 26—All plate counts were less than 100; methylene blue reduction time 20 to 26 hours.

CHLORINE STERILIZATION

The results secured from two series of experiments using a chlorine solution for the sterilization of the pasteurization equipment are given in Table 3. The bacterial contents of the raw and pasteurized milks were very low as indicated by agar plate counts and methylene blue reduction periods.

As in the previous experiments the raw milk kept well and did not become oxidized. The first 25 pounds of hot milk which passed through the equipment was almost unfit to drink within one hour due to an objectionable coal tar flavor. This milk was so strongly oxidized in one day that it was no longer suitable for consumption. The next 25 pounds of hot milk to pass through the equipment was strongly oxidized in two days and milk subsequently secured remained good in flavor for two days. There was a tendency, however, for all of this milk to be poorer in flavor than other milk after a storage of three days.

TABLE 4

Keeping quality and the copper and iron content of milk pasteurized and cooled in equipment sterilized with a chlorine solution and rinsed with hot water

MILK SAMPLE		FLAVOR SCORES				MG PER 1000 GM MILK		
No.	Treatment	1 hour	1 day	2 day	3 day	Copper	Iron	Total
R 10	Raw	22.8	22.5	21.5	22.1	0.104	0.517	0.621
R 11	Past. 0-25 lbs.	22.8	21.0*	18.0*	17.0*	0.296	0.810	1.106
R 12	Past. 25-50 lbs.	23.0	23.0	22.0	20.2*	0.197	0.585	0.782
R 13	Past. 50-100 lbs.	23.0	23.0	22.3	21.5*	0.194	0.580	0.774
R 14	Past. 100-200 lbs.	22.8	23.0	22.2	22.8	0.194	0.580	0.774
R 15	Past. 200-300 lbs.	23.0	23.0	22.7	22.8			
R 16	Past. 300-400 lbs.	22.7	23.0	22.3	22.8			
R 20	Raw	22.8	22.5	22.8	22.0	0.153	0.313	0.466
R 21	Past. 0-25 lbs.	22.8	20.3*	18.8*	20.0*	0.402	0.387	0.789
R 22	Past. 25-50 lbs.	23.0	23.0	22.8	22.2*	0.302	0.355	0.657
R 23	Past. 50-100 lbs.	22.8	23.0	23.0	22.7	0.256	0.315	0.571
R 24	Past. 100-200 lbs.	22.7	23.0	23.0	22.4	0.222	0.310	0.532
R 25	Past. 200-300 lbs.	23.0	22.8	23.0	23.0			
R 26	Past. 300-400 lbs.	23.0	23.0	23.0	22.8			

* Oxidized according to at least two of the three judges.

R 10—Plate count 2,900 to 5,200; methylene blue reduction time 15 to 22 hours; 5.3 per cent fat.

R 11-R 16—All plate counts were less than 100; methylene blue reduction time 15 to 24 hours.

R 20—Plate count 2,200 to 4,400; methylene blue reduction time 15 to 20 hours; 5.1 per cent fat.

R 21-R 26—All plate counts were less than 270; methylene blue reduction time 25 to 25 hours.

Contrary to expectations the iron and copper contents of the milks were practically identical to those of milks produced by hot water sterilization and there was no probability of explaining the differences in flavor on the basis of increased metal content of the milk.

In the experiments reported in Table 4, the chlorine solution acted on the metal of the equipment for five minutes and was then rinsed out with hot water. The bacterial content of the milk was again very low. A survey of the flavor scores indicates that the milk was of a flavor comparable to that secured by hot water sterilization. Only the first 25 pounds of hot milk through the equipment became oxidized in one day and the second 25 pounds of milk became oxidized in three days. At the end of three days all of the milk cooled subsequent to the first 50 pounds was of good flavor like the milk which passed through equipment sterilized by hot water only.

COPPER AND IRON CONTENT OF MILK

There are many references in the literature to the iron and copper content of milk as secreted by the cow and in market milk. The data secured in this study are of special interests as the newer methods of analyses were employed and the milk was not exposed to these two metals until it was ready for processing. The raw milk represents the actual composition as secreted by the cow. In the pasteurized samples if the first 100 pounds through the equipment were discarded, the analyses of pasteurized milk represent the lowest metal content that could be secured with the metal equipment used in these experiments.

The results of the six experiments are given in Table 5. The raw milk contained an average of 0.131 parts per million of copper and 0.379 p.p.m. of iron. These results are much lower than those in the literature but they compare very favorably with the copper content of milk found by Conn, Johnson, Trebler, and Karpenko for milk obtained directly in glass con-

TABLE 5
The copper and iron content of raw and laboratory pasteurized milk expressed as milligrams per 1,000 grams of milk

SAMPLE	RAW		PASTEURIZED*		INCREASE DUE TO PASTEURIZATION	
	Copper	Iron	Copper	Iron	Copper	Iron
1	0.172	0.302	0.224	0.293	0.052	- 0.009
2	0.104	0.324	0.153	0.324	0.049	0.000
3	0.155	0.456	0.203	0.537	0.048	0.081
4	0.096	0.363	0.121	0.366	0.025	0.003
5	0.104	0.517	0.194	0.580	0.090	0.063
6	0.153	0.313	0.222	0.310	0.069	- 0.003
Average	0.131	0.379	0.186	0.401	0.055	0.022

* The results given represent minimum values secured after 300 pounds of milk had passed through part of the equipment.

tainers. As a result of processing the milk the copper content was increased 0.055 p.p.m. and the iron content 0.022 p.p.m. These small increases indicate that large contaminations as frequently reported can be avoided.

DISCUSSION

The development of the oxidized flavor in milk in these experiments was accelerated by contact of hot milk within a copper-iron-nickel alloy sanitary pipe and to the outer surface of a tinned copper cooler. The copper and iron content of the first hot milk through the equipment was approximately doubled by such exposure irrespective of the method of sterilization of the equipment but the oxidized flavor was intensified to the greatest degree by chlorine sterilization not promptly followed by rinsing with hot water.

Exposure of the cold milk to the same type of metals produced no detectable increase in copper and iron in the milk and no tendency toward oxidized flavor.

It is evident that the metal itself was of major importance in these studies as exposure of hot milk to stainless steel in the pasteurizing vat did not increase the iron content of the milk or the tendency to become oxidized, irrespective of the method of sterilization.

Although it is true that increased copper and iron contents were associated with oxidized flavor, nevertheless other factors are involved as the rapidity with which this off-flavor developed and the intensity of the flavor could not be correlated with the increase in the metal content. Apparently the amount of copper and iron required to accelerate the oxidation is very small and somewhat larger amounts are of minor significance or, as is probably the case, the contact of the milk with the metal is of greatest importance. It is known that undissolved metal may catalyze reactions and it would be expected that chlorination of a copper-iron nickel alloy would clean the metal surface to give most intimate contact with the milk. After some milk had passed through the equipment there would be a protective milk coating which would reduce contact of metal and milk.

It has been clearly established with milk and ice cream by other investigators that copper added in substantial amounts does produce the oxidized flavor but the flavor may develop without exposure of milk to metals. That the tendency for milk to become oxidized in flavor is characteristic for milk of individual cows even when not exposed to metals has been clearly demonstrated by Guthrie and Brueckner (7).

Samples of the first milk from the pasteurizer over the cooler were taken at two commercial milk plants. In the one plant the equipment was chlorine sterilized followed immediately by a hot water rinse. The sanitary piping and cooler were made of tinned copper in good condition inside. The first milk through this equipment developed the oxidized flavor somewhat sooner than the remainder of the milk but the difference was slight, probably due to tin being a poor catalyst for oxidations. In the other plant

the sanitary piping was aluminum and the cooler was tinned copper without exposed copper. This equipment was sterilized with hot saline solution followed by the hot milk, part of which served to flush the equipment. In this plant the first milk into the bottle kept as well as milk cooled later, a result to be expected. It is interesting to note, however, that milk from both plants became mildly oxidized in flavor in two days whereas the milk used in the other experiments reported in this paper was usually not oxidized in three days.

CONCLUSIONS

Exposure of milk at the pasteurization temperature to certain metals increased the iron and copper content of the milk and greatly accelerated the development of oxidized or cappy flavor. The solution of metals was not affected, in these experiments, by the method of sterilization of the equipment but the development of oxidized flavor was most pronounced when chlorine sterilization was employed. Hence, the amount of dissolved copper and iron was not the only factor involved in the development of oxidized flavor. If the first hot milk through the equipment was discarded the pasteurized milk which showed a decreased tendency to become oxidized especially if the equipment was sterilized with hot water or if chlorine sterilization was followed promptly by a hot water rinse. The intensity of oxidized flavor secured in experiments of this character was shown to be greatly affected by the type of metal, and the type of chlorine solution should also affect the results.

Milk as secreted by the cow contained 0.131 parts per million of copper and 0.379 parts per million of iron. After pasteurization of the milk and after the first milk through the equipment was discarded the copper content of pasteurized milk was 0.186 p.p.m. and the iron content was 0.401 p.p.m. These data are relatively low when compared with other data in the literature.

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THE DETERMINATION OF MOISTURE IN POWDERED MILK BY THE TOLUOL DISTILLATION METHOD

E. C. THOMPSON AND R. S. FLEMING

The Borden Company, New York and Syracuse, N. Y.

Ever since Bidwell and Sterling (17) developed the toluol distillation method for the determination of moisture in organic materials, and applied it to a limited extent to powdered milk, there has been an interest in its application to the routine determination of moisture in powdered milk. The ease of operation, direct reading and rapidity of obtaining results appealed to the control operator. Wright (2) pointed out that there was some danger of obtaining results that were too high, if the heating was unduly prolonged. Thompson, Slemmons and Fleming (3) and Thompson, Johnson and Kloser (4) recommended this method for control work and gave the details of procedure. The American Dry Milk Institute (5) gives this as the method they prefer for dry skim milk powder.

In view of the increasing interest in the use of this method, it seemed wise to again consider its accuracy. A series of samples of spray process, vacuum roller and atmospheric roller milk powders, both skim and whole, was obtained and these were carefully tested for moisture both by the toluol distillation method and the vacuum oven method. The latter was taken as a standard for comparison as it has generally been considered satisfactory and has been accepted as "tentative" by the Association of Official Agricultural Chemists (6).

The aim of this investigation was to determine the correct period of distillation to obtain the most satisfactory and consistent results by the toluol distillation method; to find out if the toluol distillation method would give results that would satisfactorily check those obtained by the vacuum oven method and to determine the limit of experimental error occurring in the same and different laboratories using the both methods.

SAMPLES AND THEIR PREPARATION

Five separate batches of each of four different types of milk powders were selected. A master sample was prepared by sifting the powder through a 20 mesh copper screen into a large tin container with cover which permitted the sample to be intimately mixed by turning the can end over end and rotating about fifty times. Similar samples were prepared as duplicates of the master sample by transferring the powder immediately after mixing to one pound double friction top covered cans. The covers were placed on the cans immediately and the top and bottom of each can was dipped in paraffin. When each can was opened for experimental work, the

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TABLE 1
The influence of size of sample and time of heating upon moisture tests in percentage

Vacuum Oven Method	(Sample A)	10 Grams	20 Grams	30 Grams	50 Grams	100 Grams	Average—2.54%
	Time of Dist. in Mins.						
	10	0	0	1.27	0.67	0.80	0.40
	20	1.20	2.00	1.67	2.00	1.90	1.90
	30	1.50	2.25	2.00	2.27	2.16	2.26
	40	1.80	2.25	2.50	2.33	2.36	2.40
	50	2.00	2.50	2.53	2.40	2.50	2.50
	60	2.00	2.50	2.67	2.50	2.56	2.56
	75	2.00	2.50	2.67	2.50	2.60	2.60
	% Moist. 20° C.	1.70	2.50	2.57	2.53	2.56	2.56
	Average	1.75	2.58	2.55	2.56	2.66	
	10	1.80	1.5	1.57	1.60	1.00	1.04
	20	2.00	2.0	2.07	1.83	1.60	1.80
	30	2.20	2.10	2.30	2.17	1.80	1.90
	40	2.30	2.20	2.37	2.33	2.30	2.20
	50	2.30	2.20	2.40	2.37	2.40	2.40
	60	2.30	2.20	2.50	2.43	2.50	2.54
	75	2.40	2.20	2.50	2.50	2.60	2.60
	% Moist. 20° C.	2.30	2.20	2.33	2.30	2.56	2.56
	Average	2.25	2.28	2.39	2.56	2.60	
Vacuum Oven Method	(Sample B)	2.40%	2.39%	2.43%	Average—2.41%		
	Time of Dist. in Mins.						
	10	0	0	1.27	0.67	0.80	0.40
	20	1.20	2.00	1.67	2.00	1.90	1.90
	30	1.50	2.25	2.00	2.27	2.16	2.26
	40	1.80	2.25	2.50	2.33	2.36	2.40
	50	2.00	2.50	2.53	2.40	2.50	2.50
	60	2.00	2.50	2.67	2.50	2.56	2.56
	75	2.00	2.50	2.67	2.50	2.60	2.60
	% Moist. 20° C.	1.70	2.50	2.57	2.53	2.56	2.56
	Average	1.75	2.58	2.55	2.56	2.66	
	10	1.80	1.5	1.57	1.60	1.00	1.04
	20	2.00	2.0	2.07	1.83	1.60	1.80
	30	2.20	2.10	2.30	2.17	1.80	1.90
	40	2.30	2.20	2.37	2.33	2.30	2.20
	50	2.30	2.20	2.40	2.37	2.40	2.40
	60	2.30	2.20	2.50	2.43	2.50	2.54
	75	2.40	2.20	2.50	2.50	2.60	2.60
	% Moist. 20° C.	2.30	2.20	2.33	2.30	2.56	2.56
	Average	2.25	2.28	2.39	2.56	2.60	
Vacuum Oven Method	(Sample B)	2.40%	2.39%	2.43%	Average—2.41%		

analysis was completed as soon as possible so as to minimize the chance of moisture absorption.

METHODS EMPLOYED

(a) The Vacuum Oven Method for moisture was carried out in strict accordance with the outline for this method as given in the Third Edition of "Methods of Analysis, A. O. A. C.," each sample being dried to constant weight.

(b) The Toluol Distillation Method was carried out as described by Thompson, Johnson and Kloser (4), using the equipment recommended and following the procedure in every detail.

SIZE OF SAMPLES AND TIME OF HEATING FOR TOLUOL DISTILLATION METHOD

In an effort to determine the most satisfactory amount of powder to use in the toluol distillation method and the optimum time of distillation, two samples of spray process skimmilk powder were selected and designated as samples A and B. Moisture was determined in duplicate on 10, 20, 30, 50 and 100 gram portions. Distillation was carried on in the regular manner and the percentage moisture recovered was observed at the end of 10, 20, 30, 40, 50, 60 and 75 minutes. The final reading for the volume of water in the receiving tubes was made at 20° C. after 75 minutes' distillation. The percentage moisture was also determined on samples A and B by the vacuum oven method. These results are tabulated in Table 1.

A second series of tests were run, varying the time only. The amount of powder used was 50 grams. Three powders were used, a spray process whole milk designated as C and two roller process skimmilk powders designated as D and E. Four distillations were made on each sample for 1 hour, 1½ hours, 1¾ hours and 2 hours, respectively. Tests by the vacuum oven method were made in duplicate. The results are given in Table 2.

TABLE 2
The time required for distillation using a 50-gram sample

<i>Toluol distillation method</i>			
TIME OF HEATING	SAMPLE C Spray Whole	SAMPLE D Roller Skim	SAMPLE E Roller Skim
1 hr.	2.30	2.72	3.54
1¼ hrs.	2.34	2.90	3.54
1½ hrs.	2.36	3.00	3.64
2 hrs.	2.44	2.94	3.72
<i>Vacuum oven method</i>			
	2.22 - 2.26	2.84 - 2.83	3.54 - 3.53

ABSORPTION OF MOISTURE DURING WEIGHING

The extent to which moisture is absorbed during the weighing of samples for the toluol distillation method was determined by exposing a 50 gram

sample of spray process skim milk powder to the atmosphere of the laboratory in an uncovered metal dish, approximately $3\frac{1}{2}$ inches in diameter. The powder was spread over the entire surface evenly so that a uniform area would be exposed. At intervals of 5 minutes, the sample was weighed and mixed thoroughly to expose a new surface. These results are given in Table 3A.

Another method of determining moisture absorption was used in which 50 gram samples of the powder were spread evenly on sheets of paper to cover an area of approximately 42 square inches. One sample was immediately transferred to an Erlenmeyer flask and covered with toluol. The remaining five samples were transferred to Erlenmeyer flasks and covered with toluol after standing 5, 10, 15, 20 and 25 minutes respectively. The percentage of moisture recovered is given in Table 3B.

TABLE 3A
Absorption of moisture through exposure of powder in dish to atmosphere of 68% relative humidity

TIME OF EXPOSURE	INCREASE IN WEIGHT, GRAMS	INCREASE EXPRESSED AS PERCENTAGE
0 min.	50.0000	
5 min.	50.0127	0.0254
10 min.	50.0178	0.0356
15 min.	50.0206	0.0412
20 min.	50.0222	0.0444

TABLE 3B
Absorption of moisture through exposure of powder spread on paper

TIME OF EXPOSURE	MOISTURE CONTENT
0 min.	2.98%
5 min.	3.06%
10 min.	3.28%
15 min.	3.30%
20 min.	3.40%
25 min.	3.30%

RESULTS OBTAINED IN DIFFERENT LABORATORIES

In order to determine whether different laboratories would secure substantially the same results on duplicate samples, a series of dry whole and skim milk powders were prepared from the different methods of manufacture and five master samples of each type obtained. From these master samples, duplicate samples of 300 grams each, were prepared and two of each series were sent to two different laboratories. The moisture content was determined by both methods in triplicate on each sample in each laboratory. The results are given in Table 4.

TABLE 4

Comparison of moisture percentage secured by two different laboratories on the same samples of powder

Atmospheric roller skim powder

SAMP. NO.	VACUUM OVEN METHOD			TOLUOL METHOD		
	Lab. A	Lab. B	Average	Lab. A	Lab. B	Average
1.	2.72	2.89	2.81	2.75	2.77	2.76
2.	3.57	3.69	3.63	3.59	3.60	3.60
3.	2.85	2.77	2.81	2.89	2.77	2.83
4.	3.95	3.97	3.96	3.95	3.94	3.95
5.	3.88	3.93	3.91	3.95	3.88	3.92
<i>Spray process skim</i>						
6.	2.31	2.31	2.31	2.29	2.27	2.28
7.	3.21	3.25	3.23	3.17	3.22	3.21
8.	2.50	2.61	2.56	2.56	2.63	2.60
9.	2.81	2.76	2.79	2.77	2.77	2.77
10.	2.37	2.44	2.42	2.40	2.47	2.44
<i>Spray process whole powdered milk</i>						
1.	2.13	2.16	2.15	2.01	2.12	2.07
2.	2.03	1.99	2.01	1.93	2.05	1.99
3.	2.10	2.06	2.08	1.94	2.05	2.00
4.	2.10	2.12	2.11	1.97	2.09	2.03
5.	1.84	1.86	1.85	1.83	1.76	1.80
<i>Vacuum drum skim</i>						
1.	3.05	3.13	3.09	3.01	3.01	3.01
2.	2.82	2.82	2.82	2.89	2.81	2.85
3.	2.55	2.63	2.59	2.77	2.67	2.72
4.	2.88	3.01	2.95	2.86	2.97	2.92
5.	2.73	2.87	2.80	2.84	2.89	2.87

DISCUSSION

It is apparent from the results given in Table 1 that a ten gram sample gives low results with the toluol distillation method. The reason for this is not clear but it may be due to the small size of the sample as compared with the large capacity of the equipment. A 20, 30, or 50 gram sample gives results which check very well with those obtained by the oven method, the greatest variation being 0.15%. A 100 gram sample gives fairly satisfactory results, but because of requiring constant attention to prevent burning it is not recommended. For reasons of uniformity, it seems desirable to settle on 50 grams as the standard amount to use.

Tables 1 and 2 indicate that a distillation period of less than 60 minutes is insufficient. A distillation period of more than 60 minutes is sometimes necessary. When additional moisture comes over between 50 and 60 minutes, the distillation should be continued to 75 minutes as a limit.

The results given in Tables 3A and 3B indicate the ease with which milk powders will absorb moisture. Moisture may be absorbed from the air or

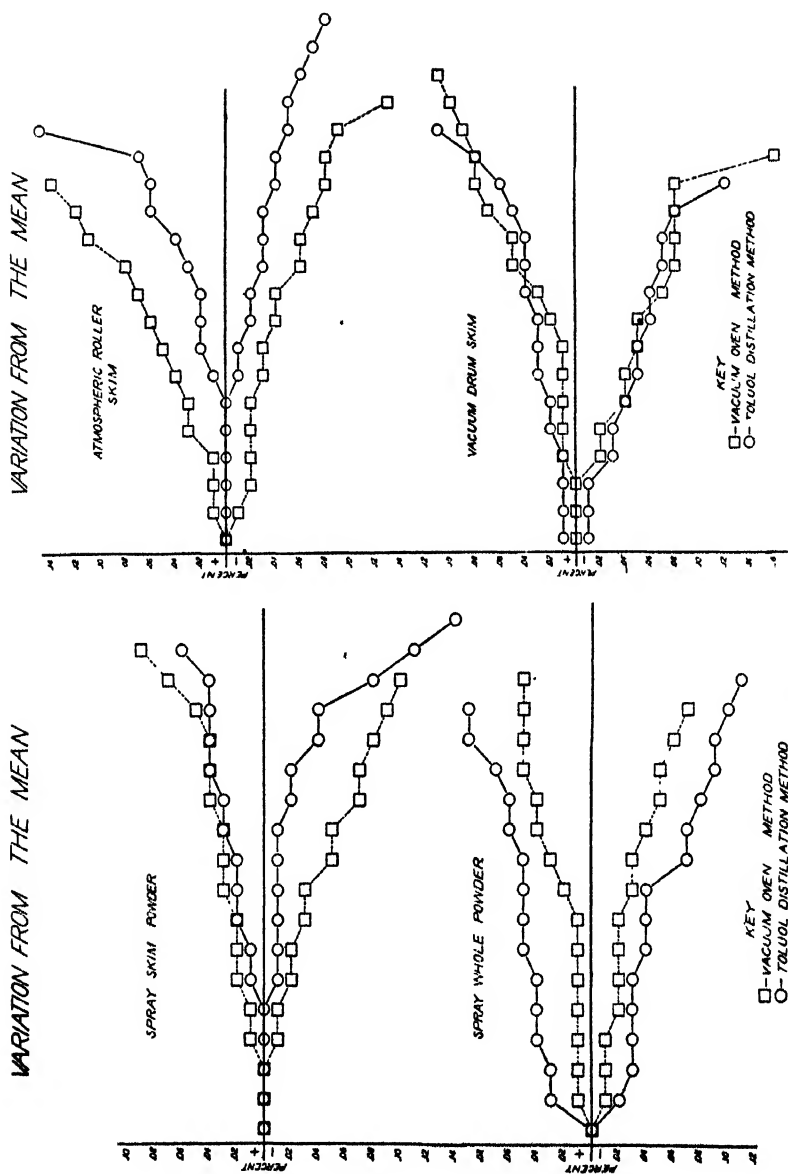


Fig. 1. The variations of each individual test from the average percentage of moisture secured by both laboratories.

from the paper on which the powder is weighed. The practice of mixing large samples on sheets of ordinary paper is undesirable. Moisture samples should be weighed out as quickly as possible when using either method and in the toluol distillation method, they should be covered immediately with toluol after weighing.

Table 4 gives the results as obtained on all samples in the different laboratories and shows very satisfactory agreement.

Figure 1 shows the variation from the mean for each individual test obtained from both laboratories by both methods. The variations in results from the mean are no greater by one method than by the other which justifies the conclusion that the toluol distillation method for milk powder is entirely satisfactory.

CONCLUSIONS

1. A 30- or 50-gram sample is satisfactory for determining moisture by the toluol distillation method. For the sake of uniformity, the 50-gram sample is recommended.

2. The time of distillation should not be less than 60 minutes. It may be necessary, in some cases, to continue the distillation for 75 minutes. Prolonged distillation up to 1½ hours may result in a disintegration of the powder which is evidenced by considerable discoloration.

3. Milk powders absorb moisture when exposed to the atmosphere which makes it necessary to prepare and weigh out samples as quickly as possible.

4. The toluol distillation method has four distinct advantages:

- a. It enables the use of a large size sample.
- b. Each determination can be completed in about one hour.
- c. It is readily adapted for plant control work.
- d. It is just as accurate as the vacuum oven method.

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STUDIES ON THE EMULSIFYING SALTS USED IN PROCESSED CHEESE*

HUGH L. TEMPLETON AND H. H. SOMMER

College of Agriculture, Madison, Wisconsin

In the manufacture of processed cheese certain salts are used for the purpose of preventing the separation of fat from the cheese and at the same time giving the finished product the desired body and texture. For want of a better name these salts are known as emulsifiers. In previous papers (1, 2) various researches on processed cheese have been described in which sodium citrate, sodium-potassium tartrate or Rochelle salt, and the disodium salt of orthophosphoric acid were used as the emulsifying salts. In the meantime a number of European investigators have published their results in which they confirm the statement that at the present time sodium citrate is the most satisfactory emulsifying agent for the manufacture of processed cheese. Thus in a paper on the use of sodium metaphosphate Umbrehet (3) compares cheese made with this emulsifier with that made with sodium citrate, the latter being taken as the standard.

Habicht (4) has presented a very comprehensive study of the salts that may be used as emulsifiers; he concludes that the ideal emulsifying salt combines an alkaline monovalent cation with a polyvalent anion, *i.e.*, a tri- or quadrivalent anion. To illustrate the importance of the valence of the anion, Habicht (5) states that the relative emulsifying properties of sodium acetate, disodium tartrate, and trisodium citrate are 1:20:100. Habicht (4) found that tetrasodium pyrophosphate and tetrasodium ferrocyanide were very satisfactory emulsifying salts, although their effectiveness was not as great as might be anticipated from an extrapolation of the above ratio. The ferrocyanide is only of theoretical interest since its toxicity precludes its use. The cations with a higher valence than unity were found to be unsatisfactory even when combined with a trivalent anion. Of the various monovalent, alkaline cations, potassium or lithium tend to impart a very characteristic and peculiar flavor to the resulting product such as is common with all their salts. Between sodium and ammonium salts the former would be preferable on the basis of flavor.

Habicht (4) seeking a physico-chemical explanation of emulsifiers advances the view that under the influence of heat and agitation certain combinations take place within the cheese mass. He suggests that there is a partial saponification between the cation of the salt and the fatty acids, and that the anion, which is a solvent for casein, combines with this portion of

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the cheese in such manner that there is a film of casein surrounding each fat globule to prevent the escape of fat from the cheese mass.

It is known that there are combinations of cheese which may be heated without the use of an emulsifier and from which there will be no appreciable escape of fat. Other combinations will lose fat rapidly and this fat may never be completely re-incorporated in the cheese mass when heated without the use of emulsifiers. This phenomenon seldom occurs when an emulsifier is used so that its appearance is direct proof of a poor selection of cheese and the use of the wrong type of emulsifying salt. When emulsifiers are used there may be some separation of fat in the early stages of the process, but the fat is re-incorporated as the heating continues so that the final product is homogeneous with no evidence of free fat. Of the number of salts that have been suggested as emulsifying agents only a few have proved to be of practical interest. Many have only a theoretical interest because of some inherent property which they possess, for example, toxicity. The suggestion has been made (6) that the number of hydroxyl groups in an organic hydroxy acid is responsible for the emulsifying action of that particular salt; thus one might enumerate a number of salts that offer possibilities as emulsifying agents for processed cheese.

This paper presents a comparison of potassium citrate, tetrasodium pyrophosphate, sodium metaphosphate and a fusion mixture of equal parts of the mono- and disodium salts of orthophosphoric acid with sodium citrate. Another comparison involving salt and the disodium salt of orthophosphoric acid with sodium citrate is included. The salts were used separately in amounts ranging up to 5 per cent for the pyro- and metaphosphates and the sodium citrate. Three per cent of potassium citrate was the maximum because it was noted that this concentration had a noticeable effect upon the flavor of the cheese. Due to the limited cheese supply only two samples were made with the phosphate fusion mixture although tests with other cheese indicated that two per cent is the maximum concentration that could be used on account of the acidic nature of the salt. While the legal maximum for the added salts is three per cent of the weight of the cheese mass it seemed advisable to exceed these limits in order to gain more information on the action of the salts at higher concentrations.

Analyses of the processed cheese samples were made to determine the changes in the ash, total nitrogen, water soluble nitrogen and 5 per cent NaCl soluble nitrogen contents. Other properties studied were the loss of fat from a definite volume of cheese upon standing, and the loss of moisture during a storage period of almost one year. In addition the usual measurements were made for the determination of the pH of the cheese, the titratable acidity and the resiliency as measured by the resistance of one inch cubes of cheese to crushing (1).

The raw material used was a blend of cheddar cheese that ranged in age from about 4 to 13 months, with the average age being approximately eight

TABLE 1
Effect of varying amounts of emulsifying salts on the properties of the processed cheese

SAMPLE NO.	EMULSIFIER		MOISTURE PERCENTAGES			DIH DETERMINATIONS WITH QUINHYDRONE		TITRATABLE ACIDITY %	BODY IN GRAMS	FAT LEAKAGE FROM CHEESE IN SQUARE INCHES
	Kind	%	Average first two	Third	Loss as % of average	Cheese paste	Cheese 1:10 suspension			
1	Control		38.88	34.77	10.57	5.43	5.86	1.59	1233	3.53
2	$\text{Na}_2\text{C}_4\text{H}_4\text{O}_7$	1.0	40.14	34.86	13.15	5.48	5.97	1.54	849	6.32
3	"	2.0	39.88	36.79	7.75	5.62	6.12	1.26	1087	1.94
4	"	3.0	39.92	37.75	5.44	5.65	6.15	1.30	923	1.77
5	"	4.0	39.58	38.36	3.08	5.78	6.30	1.34	970	1.67
6	"	5.0	39.09	37.35	4.45	5.99	6.37	1.32	1159	0.93
7	$\text{K}_2\text{C}_4\text{H}_4\text{O}_7$	3.0	38.54	36.09	6.60	5.68	6.15	1.48	850	2.16
8	"	2.5	38.51	35.55	7.69	5.68	6.19	1.48	1246	1.81
9	"	2.0	38.33	36.34	6.67	5.61	6.12	1.36	953	1.43
10	"	1.5	38.72	36.05	6.89	5.57	6.03	1.58	908	3.14
11	"	1.0	39.19	36.78	6.15	5.55	5.95	1.62	798	5.85
12	$\text{Na}_2\text{P}_2\text{O}_7$	5.0	37.66	34.83	7.51	6.03	6.49	1.42	1025	1.54
13	"	4.0	38.06	35.52	7.19	6.02	6.52	1.58	1229	1.41
14	"	3.0	38.41	36.19	5.78	5.96	6.40	1.42	1255	2.35
15	"	2.0	38.74	35.82	7.54	5.74	6.26	1.68	1171	3.14
16	"	1.0	39.36	36.62	6.96	5.60	6.12	1.31	1361	1.35
17	NaPO_3	5.0	38.17	34.18	10.45	5.30	5.80	2.79	1982	2.52
18	"	4.0	38.12	35.41	7.11	5.21	5.65	2.81	2096	3.02
19	"	3.0	37.99	34.51	9.16	5.20	5.68	2.68	2034	3.56
20	"	2.0	38.36	31.16	18.77	5.27	5.72	2.52	1981	3.37
21	"	1.0	38.66	35.32	8.64	5.36	5.78	2.29	1675	2.78
22	NaH_2PO_4 and Na_2HPO_4	2.0	38.63	33.49	13.31	5.32	5.77	2.01	1704	2.16
23		1.0	38.64	35.24	8.80	5.34	5.75	1.98	1102	5.73

months. To insure the thorough mixing of the cheese mass it was ground twice through a power driven food mill. The cheese mass was heated directly with steam, care being taken to open the inlet valve the same amount for each sample and the length of time that the steam was turned on was noted with a stop-watch. In this connection it was interesting to note the difference in steam time necessary to give the cheese mass the same apparent consistency. The samples prepared with sodium citrate required about 6 per cent less time than the others and as will be noted from table 1, these samples had a slightly higher moisture content than the others. With the higher percentages of emulsifiers the cheese mass was more difficult to stir in the kettle because the molten mass had a firmer consistency than those made with the usual amounts of emulsifiers.

Analytical data on the moisture content, the pH as determined by two methods, the titratable acidity calculated as lactic acid, and the body of the cheese as measured by the resistance of one inch cubes to crushing are given in table 1. The data on the moisture content include the average of the first two examinations, made shortly after processing as compared with a third examination made after nearly a year in storage. The pH and titratable acidity values are quite consistent, varying with the type and the amount of emulsifier used in the cheese. The samples made with metaphosphate were highest in acidity with the fusion mixture second. The sodium and potassium citrates are nearly identical for the same concentrations of the salts. As was expected from the acid reaction of the metaphosphate samples, the body of these samples as measured by the resistance to crushing was somewhat greater than the others. In the first column under pH determination the cheese was worked to a paste with quinhydrone while in the second determination the quinhydrone was added to the 1:10 aqueous suspension of the cheese which had been prepared for the titratable acidity determination.

The method used for the determination of moisture in the processed cheese consisted in thoroughly mixing a rather large sample and then weighing out duplicates of about two grams each into 52 mm. porcelain crucibles equipped with porcelain covers. The crucibles were placed in a steam oven with the covers slightly raised to permit the escape of moisture and still prevent any loss of cheese due to spattering. The samples were kept in the oven for four hours with a twenty-inch vacuum being drawn for the last two hours. The crucibles were then removed to a desiccator, cooled and weighed. As longer dehydration periods failed to produce any appreciable changes in the weight of the residue, it was assumed that this method might be used in place of the longer official method. Of course the weight of cheese used is less than with the official method, but with very few exceptions, the duplicate determinations showed very good agreement.

The third examination for the moisture content was made after the samples had been in storage for more than eleven months. All of the samples of cheese were stored under the same conditions of temperature and humidity in the original tinfoil lined boxes, which had the covers nailed on within a few hours after the molten cheese had been filled into the foil. Table 1 shows that the cheese samples suffered considerable moisture loss during the eleven month storage. These results were obtained incidentally, and while, as far as is known, all the samples had equal opportunity for moisture loss, no detailed record was made of the possible factors. While no close correlation is evident between the moisture loss and the amounts and kinds of emulsifying salts used, the results do suggest a possible relation between emulsifying salts and the tenacity with which the moisture is held. This phenomenon may warrant further study.

The total ash of the processed cheese was obtained in the usual manner of ashing the residue from the moisture determination in an electric furnace. As can be seen from Fig. 1, the results were quite in accordance with ex-

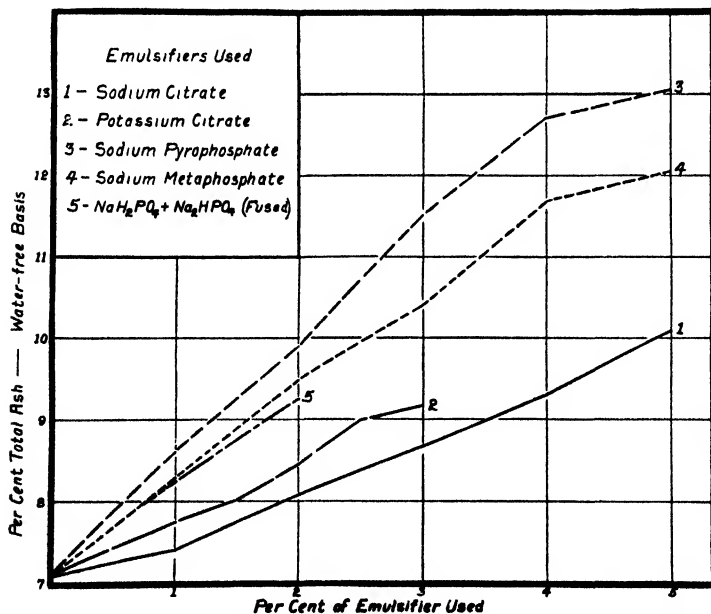


FIG. 1. RELATION OF THE EMULSIFYING SALTS TO THE TOTAL ASH CONTENT.

pectations, namely, the percentage of the ash increased with the amount of emulsifier used. All values are presented on a moisture free basis so as to make them comparable. The total ash was carefully extracted with warm water and then filtered to remove the insoluble portion. The crucible and insoluble residue were washed with water so that the filtrate and washings

were less than 100 cc. The aqueous extract was then made up to 100 cc. and divided into two equal portions. One of these was acidified with 5 cc. of N/14 sulfuric acid, boiled to expel CO_2 , cooled and titrated with N/14 NaOH to determine the amount of basic materials in the ash. The results have shown that the increase in basic materials is approximately proportional to the increase in the amount of emulsifier used in the cheese. The second portion of the aqueous extract was titrated with standard silver nitrate using potassium chromate as the indicator, and the results calculated as the per cent of sodium chloride present in the cheese. The results of this determination were quite uniform and consistent for the samples containing either of the citrates or Rochelle salt, but with any of the phosphates the results varied widely, indicating that in order to make a satisfactory determination of the chloride in the presence of phosphates a different ashing procedure must be used. Checks on the method as indicated by the control samples without emulsifiers were very satisfactory. The water insoluble portion of the ash remaining on the filter paper was returned to the furnace and the results of the second ashing expressed as the water insoluble fraction of the total ash. Here again the results showed consistent increases with increasing amounts of emulsifiers when citrates or tartrate were used, but with the phosphates there was no evident correlation.

Determining the leakage of fat from cheese samples is a new test that had its origin in the observation that varying oily areas were left on paper after a number of cheese samples had been laid out for examination and judging. In the first applications of this test the sample of cheese was placed on a piece of filter paper, but this proved to be unsatisfactory as this paper did not show sufficient differentiation; other papers were tried until a white paper was found which gave more satisfactory results. This appeared to be a relatively short fibered paper as the fat spread quite uniformly in all directions from a piece of cheese placed in the center of the paper. The method as finally adopted consists in taking a cylindrical portion of the cheese 0.5 inch thick and 0.71 inch in diameter (0.198 cubic inches) from near the center of the sample with a cork borer. One face of this cylindrical sample (0.396 square inches) is placed in intimate contact with the paper in an incubator at 37.78°C . (100°F .) for two hours. The paper and cheese are then removed to room temperature for twenty hours. At the end of the this time the piece of cheese is removed from the paper which is then held against a pane of glass towards a source of light and the area that has been rendered translucent by the fat is carefully marked off, thereby avoiding difficulties due to further spread of the fat before the area can be measured. While the translucent area is never exactly circular in shape enough measurements can be made so that it is possible to arrive at a rather close approximation of the area. The results are presented in table 1. With one per cent concentration of the citrates and the fusion mixture of the salts

of orthophosphoric acid there is a rather decided loss of fat as compared with the other phosphate samples; at two per cent the situation is reversed and from there on the metaphosphate samples show a greater fat leakage than the others. Sodium citrate showed a continual decrease in the fat loss with increasing emulsifier content while the pyrophosphate showed a slight increase.

The total nitrogen in the various samples of processed cheese was determined by the usual Kjeldahl method. The results are presented in figure 2.

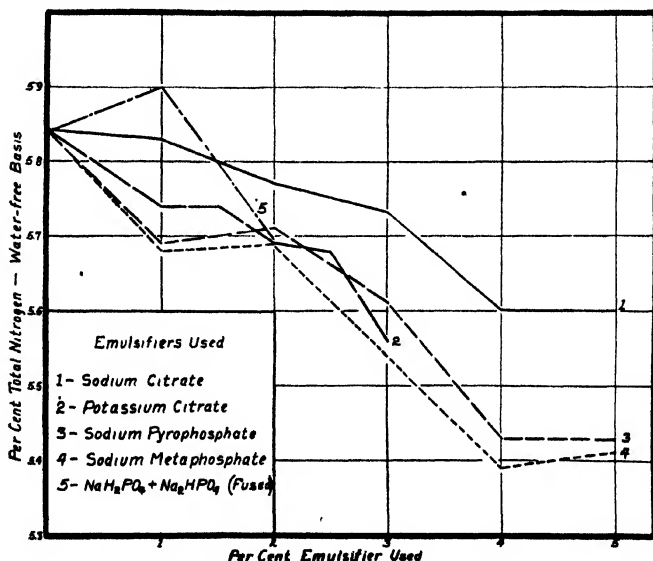


FIG. 2. RELATION OF THE EMULSIFYING SALTS TO THE TOTAL NITROGEN.

From this it is evident that with all of the emulsifiers used the nitrogen percentage of the cheese (water free basis) decreased as the amount of salt increased. The addition of dry matter in the form of salts does not fully account for this decrease. Two possibilities suggest themselves in explanation of this fact. It might conceivably be due to less exhaustive drying in the moisture determinations. It is more likely due to escape of nitrogen as vapors from the cheese mass during the processing operation. Any one who has visited a large cheese processing factory knows that the vapors from the heating units carry away considerable volatile materials.

The water soluble nitrogen in the cheese determined by a modification of the usual method which calls for a 24-hour extraction with occasional shaking, using chloroform to prevent bacterial action. The change consisted in the use of motor driven laboratory stirrers which kept the cheese

and water in vigorous agitation for a period of three and one-half hours. It was felt that this change would give comparable results with a marked saving in time. The results presented in figure 3 show that the water soluble nitrogen increases with the percentage of emulsifying salt used.

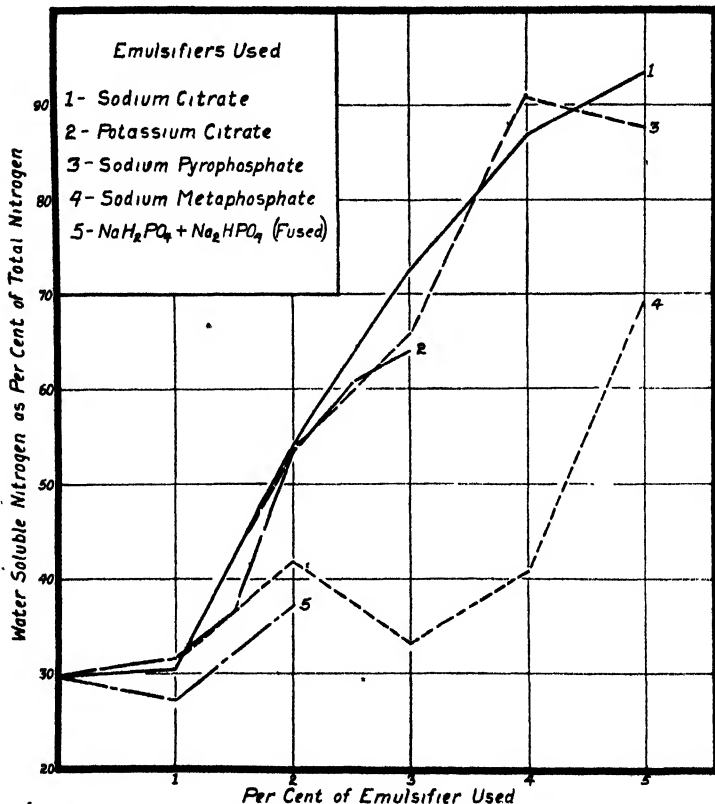


FIG. 3. RELATION OF THE EMULSIFYING SALTS TO THE WATER SOLUBLE NITROGEN.

As might be expected from the results of the study of the water soluble nitrogen in the cheese mass there was not very much nitrogenous matter left to be determined in that fraction which is soluble in a 5 per cent solution of sodium chloride. This is especially true of the samples made up with 4 and 5 per cent of sodium citrate and pyrophosphate as shown in figure 4. Potassium citrate is in excellent agreement with the sodium salt. The metaphosphate gives the cheese a somewhat more acid reaction than the other salts and this is shown in the decrease in the water and salt soluble fractions. The same holds true for the fusion mixture. The effect of these salts is not as pronounced as the addition of acid to the cheese mass in decreasing the

amount of nitrogen that may be found in the water and salt solution fractions. A limited number of experiments have shown that the addition of acids in amounts sufficient to give the cheese a grainy, curdy appearance will reduce the water and salt soluble nitrogen of the cheese very decidedly.

The sum of the water and 5 per cent sodium chloride soluble fractions as per cent of the total nitrogen is shown in figures 5 and 6. The first of these

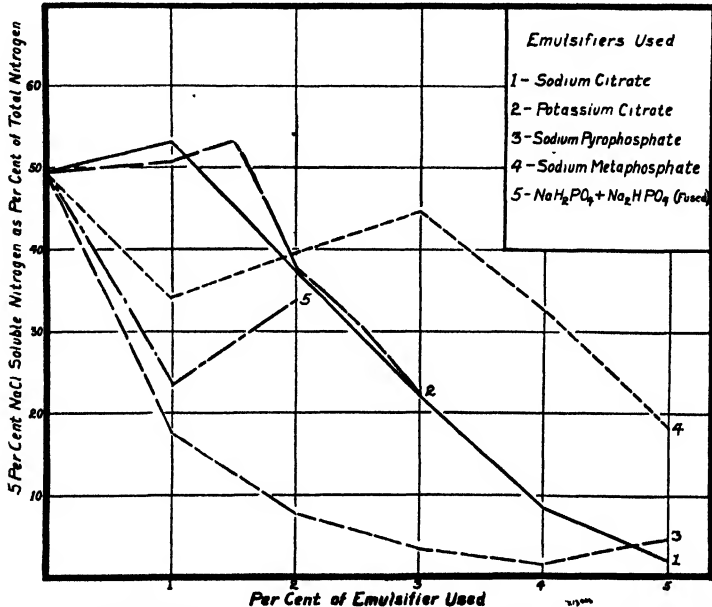


FIG. 4. RELATION OF THE EMULSIFYING SALTS TO THE 5% NaCl SOLUBLE NITROGEN.

shows that there is relatively little difference between sodium citrate and Rochelle salt, but disodium phosphate (ortho form) shows slightly lower values. This chart also shows that there is very little difference in the results from the use of direct steam or indirect steam for heating the cheese mass. According to the results shown in figure 6 it is evident that there is very good agreement between the two citrates within the range of comparison although no explanation may be offered at this time for the drop with three per cent of potassium citrate. It is interesting to note that all of the phosphates show a very low value for the sum of the water and 5 per cent sodium chloride soluble fractions with only one per cent of emulsifier, this value however increases rapidly especially at 4 and 5 per cent concentration so that at the latter figure the pyrophosphate has almost the same value as the sodium citrate. Analyses of raw cheese about to be used for processing have indicated that there is some evidence to support a theory that in the comparison of a number of cheeses of the same age, the sum

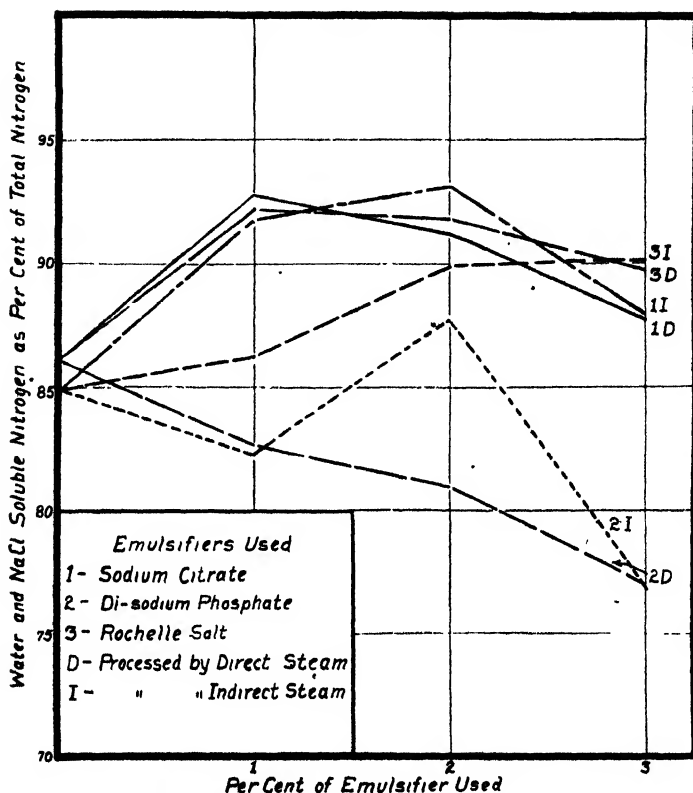


FIG. 5. RELATION OF THE EMULSIFYING SALTS TO THE SUM OF THE WATER AND 5% NaCl SOLUBLE NITROGEN.

of the water and salt soluble nitrogen fractions will be higher for the cheese of the better quality. The data collected however are not sufficient to warrant a more definite statement until further analyses have been made involving cheeses of varying ages and degrees of quality.

A study was also made of the changes occurring in the appearance of the tinfoil when it was removed from the cheese samples, but these results will be presented in another paper which will deal specifically with the subject of wrappers or wrapping materials suitable for processed cheese.

A summary of the properties of the various samples as determined by the senses of taste, smell and sight indicated that the samples of cheese made with sodium citrate were the most satisfactory. Potassium citrate gave the cheese an unnatural bitter taste which became more pronounced with storage. When three per cent of this emulsifier was used the cheese had a rather unpleasant aroma, a defect which was also noted when three

per cent or more of the phosphates was used. The samples containing one or two per cent of the pyrophosphate were very satisfactory as regards flavor, but with higher concentrations the cheese had a tendency to be bitter. With the metaphosphate the cheese had a rather sour taste which was not sufficient to be unpleasant, but to the person desiring a mild flavor this cheese might be considered as objectionable. The limited solubility of these two phosphates is a factor that must be considered in their use especially when direct steam heating is employed since it is then necessary to

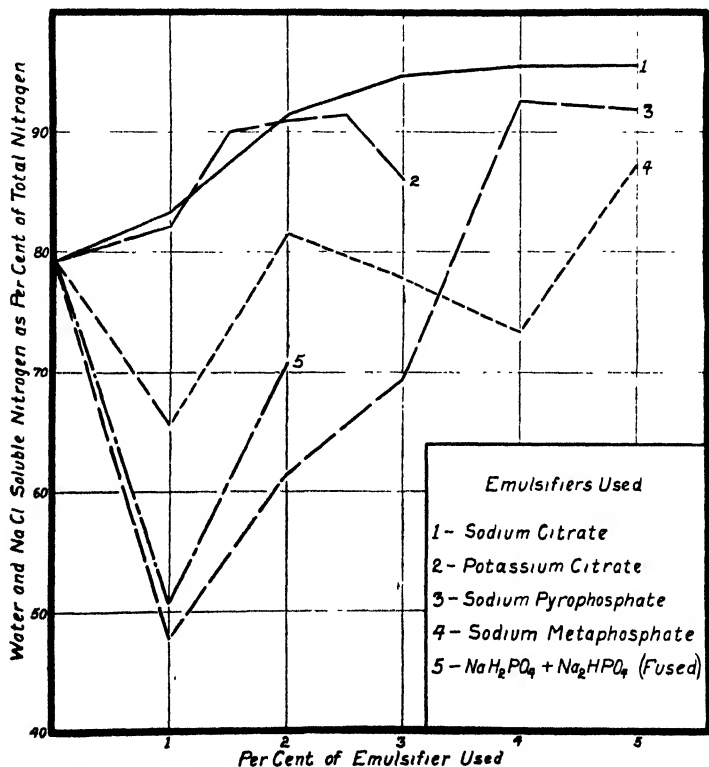


FIG. 6. RELATION OF THE EMULSIFYING SALTS TO THE SUM OF THE WATER AND 5% NaCl SOLUBLE NITROGEN.

add the salts in a dry form. In the last examination of the samples it was noted that all of the samples containing three per cent or more of the pyrophosphate showed large lumps of white, salty material which gave every indication of being a point at which the emulsifier in the cheese had crystallized. These lumps were large enough to cause the surface of the cheese and the tinfoil to bulge out and at the same time cause discoloration of the cheese around them.

One test which is used by the commercial manufacturers of processed cheese is the melting test. In this a definite volume of cheese is placed on a hot plate or the cover of a hot water bath and allowed to melt; the ease with which it melts and spreads over the heating surface is taken as the criterion of desirability for that particular sample of cheese. When either the meta- or pyrophosphates were used the cheese did not melt but lost moisture while retaining its original shape. With the other salts the cheese mass usually spread out until it covered the bottom of the dish in which it was being heated.

The results of this study of emulsifiers may be stated as confirming previous findings, namely that none of the emulsifiers used are superior to sodium citrate and it is very doubtful if any of them are equal to sodium citrate when all the factors are considered.

In conclusion the authors wish to express their thanks to the Chas. Pfizer & Co., Inc., for the fellowship under which this investigation has been conducted.

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EFFECT OF SALTS ON THE SOLUBILITY OF CASEIN AND PARACASEIN

PAUL F. SHARP AND T. J. MCINERNEY

Department of Dairy Industry, Cornell University, Ithaca, N. Y.

Initially this investigation had three objectives: first, to study the physico-chemical properties of commercial casein prepared from the same milk by different methods; second, to obtain information bearing on the methods of following the alterations in the protein fractions during cheese ripening; and third, to obtain an independent check on the work of Michaelis and Mendelssohn (8).

Van Slyke and Hart (15) (16) (18), Van Slyke and Bosworth (14), and Bosworth (2) in their studies of the changes in the protein fractions during cheese ripening determined among other things what they termed the "salt soluble protein." They believed that the casein underwent the following sequence of changes during cheese making and ripening: (1) casein, (2) paracasein, (3) protein soluble in warm salt solution, (4) protein insoluble in warm salt solution, (5) water soluble protein, and finally (6) proteoses and small split products. They called attention to the influence of acidity on the formation of the salt soluble protein, and showed that during the first few hours of cheese making practically all of the paracasein is converted into the salt soluble protein.

Orla-Jensen, Meyer and Orla-Jensen (9) found that the solubility of paracasein passed through a maximum when increasing amounts of lactic acid were added to milk previously coagulated with rennin and to which salt had been added. No appreciable increase in solubility was found in the absence of salt or in milk to which no rennet or salt had been added.

Michaelis and Mendelssohn (8) found that paracasein shows two flocculation zones, one at pH 4.5 to 4.6 and another at pH 6.0 to 6.4. Between pH 4.6 and 6.0 and above pH 7.0, the paracasein remained in suspension.

The results presented here indicate that the salt solubility of the protein is merely a reflection of the change in hydrogen-ion concentration of the extracting solution or cheese and that the paracasein can be made salt soluble or salt insoluble at will by changing the pH.

EXPERIMENTAL

The dried samples of the commercial type of rennet, grain curd, sulfuric acid and sulfuric acid cooked curd casein used in this study were prepared by Dr. W. V. Price. The sample of purified casein (ash 0.06%) was prepared by Dr. R. Whitaker. The procedure used in determining the solubility of the casein was patterned after the method of Van Slyke and Hart

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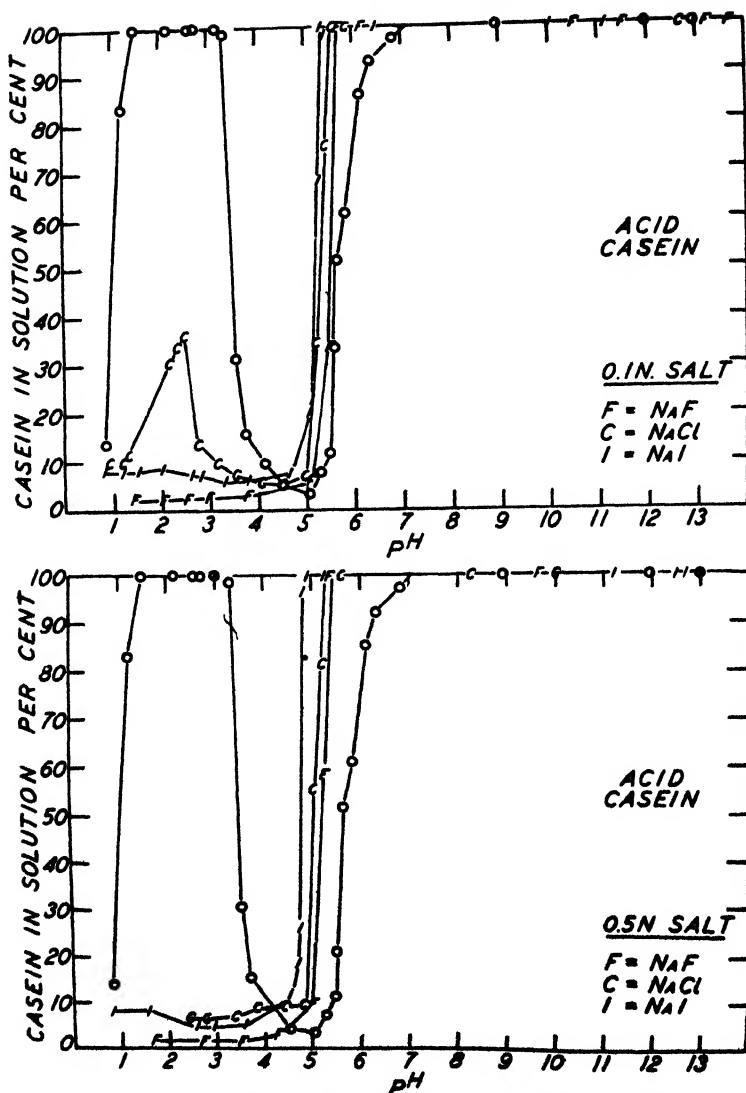


FIG. 1. THE EFFECT OF pH AND SALTS ON THE SOLUBILITY OF CASEIN PRECIPITATED WITH HYDROCHLORIC ACID.

(15) (16) (18). To one gram of the dried casein, 25 ml. of distilled water were added, and the suspension was allowed to stand over night in a refrigerator. The next morning solutions of either HCl or NaOH and the proper amount of a solution of the selected salt were added and the result-

ing mixture was made up to a total volume of 100 ml. The suspension was heated with occasional shaking for one hour in a water bath held at 50–55° C. It was next filtered through a packed cotton pad and the nitrogen in an aliquot of the filtrate was determined by the Kjeldahl method. Another portion of the filtrate was used for the determination of the pH at 25° C.

The solubility curves obtained with the grain curd casein are presented in Figure 1. The data obtained with the other commercial acid caseins as well as the purified casein superimpose almost exactly upon the curves given in Figure 1, and are therefore omitted.

The salts in the order fluoride, chloride and iodide tend to shift the alkaline solubility zone to a more acid region, the shift being greater the higher the concentration of the salt. Sharp and De Tomasi studied this effect on the precipitation of casein from milk, and found that in very high concentrations of sodium chloride, acid must be added until an electrometric pH reading of 2.0 or 3.0 is reached before the casein is precipitated. It is noted that the salts used in Figure 1 reduce or prevent the solution of casein in the region of pH 3.0. These curves were used to predict the effect of pH and salts on the churning time of cream, which resulted in the paper by Guthrie and Sharp (5).

The curves obtained with paracasein (commercial rennet casein) are shown in Figure 2. This type of casein is high in ash and contains appreciable amounts of calcium. In the absence of added salt the zone of insolubility of the paracasein is from pH 4.5 to 7.5. The iodide and particularly the chloride shifted the zone of insolubility further into the alkaline region, the shift increasing with the concentration of the salt added. Sodium iodide and sodium chloride, however, caused a similar displacement of the peptizing zone in the region from pH 5.5 to 4.5 in the case of both the acid and the rennet casein.

Sodium fluoride has long been used as a plasticiser for rennet casein. It shows an anomalous behavior when compared with the chloride and iodide. Calcium fluoride is very slightly soluble. Perhaps the upper half of the curve obtained with sodium fluoride and its plasticising properties toward rennet casein are partly accounted for by the removal of the calcium to form the insoluble calcium fluoride. The upper part of the sodium fluoride curve moves to the right with increasing concentration. In this respect it shows some of the tendencies as shown by the chloride and iodide.

The peptizing effect of the salts on paracasein in the zone between pH 5.0 and 6.5 is of special interest. The iodide is more effective than the chloride. The effect of each increases with the concentration. Figure 2 indicates that if a suitable concentration of sodium chloride between 0.1 and 0.5 normal were selected, the paracasein would show three zones of solubility about as follows: pH 2.5, 6.0 and 9.5. It would show zones of insolubility at pH 1.0, 4.5, 7.0–9.0, and a hypothetical one at 11.5. The zones

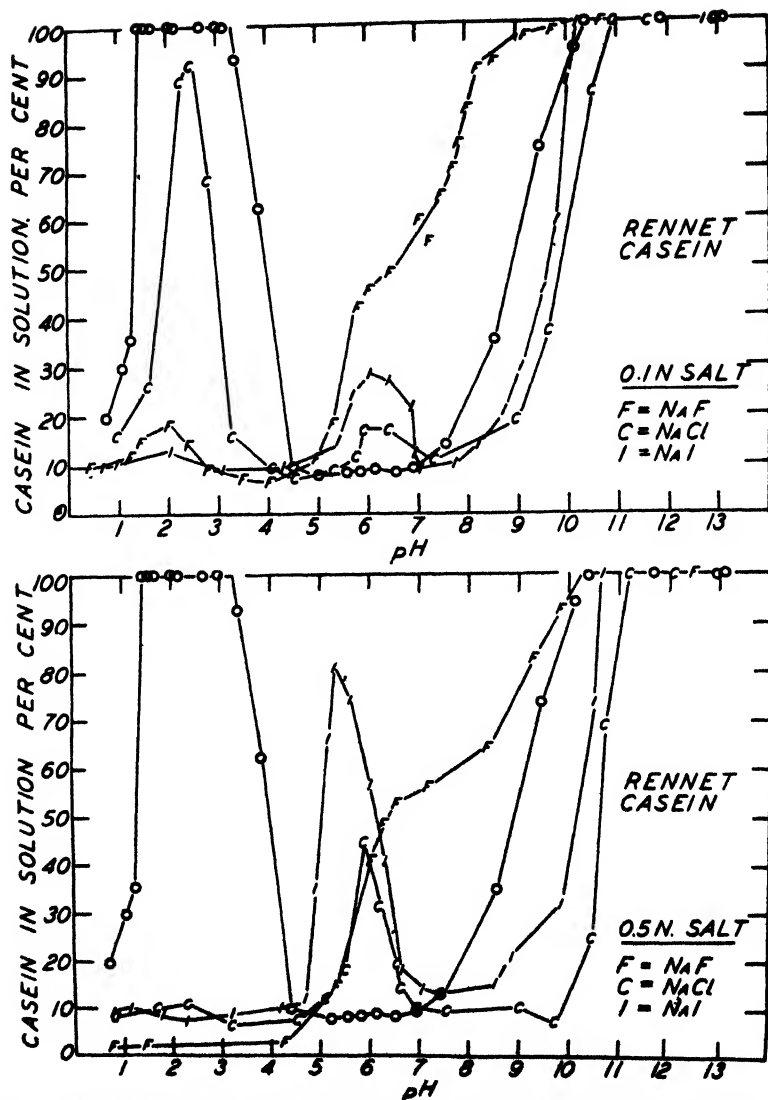


FIG. 2. THE EFFECT OF pH AND SALTS ON THE SOLUBILITY OF CASEIN COAGULATED WITH RENNIN (PARACASEIN).

shift with the concentration of the salt. The curves in Figure 2 are in general agreement with the experiments of Michaelis and Mendelssohn. Bostrom (1) states that calcium paracasein is not precipitated above pH 10.0. Figure 2 indicates that the salt soluble protein determination has

little significance in the measurement of the actual chemical changes in the protein as a result of cheese ripening.

The fact, however, that sodium chloride solutions with pH values near 5.5 to 6.0 disperse paracasein, is of great practical importance in cheese making. Van Dam (13) found that the increased dispersion accelerated digestion by pepsin. On the other hand Van Slyke and Hart (17) found that the actual rate of ripening was inversely related to the salt content. Riddet, Valentine, McDowall and Whelan (10) reached the conclusion that a normal salt content corresponding to 4.82 per cent in the water of the cheese gave the best body. McDowall and Whelan (7) found that concentrations of salt in excess of about 4 per cent retarded the rate of acid production by *Streptococcus lactis*. They are inclined to explain the adverse effect of high salt in cheese ripening as due to retarded bacterial growth. cheddar cheese is usually not salted until it is far along in the making process, when the acid development is well under way and the lactic acid bacteria are present in the curd in large numbers. If the curd is salted before the pH reaches 5, the plasticising effect of the salt on the curd particles should be observed at the time of salting. Some cheese makers use more salt, the higher the fat content of the milk or curd. This would tend to increase the concentration of salt in the water of the cheese. Insofar as ripening is concerned, the concentration of salt in the water is the important thing, and not the amount in the cheese as a whole.

Apparently under some conditions salt may have an adverse effect upon ripening. In many of the studies, however, the moisture content of the cheese has decreased with the increase in salt and has varied during the ripening. In order to compare the effect of salt on texture alone, comparable degrees of ripening and the same moisture content and composition must be assumed.

The curves in Figure 2 suggest that at pH values near 5 and 7 a smooth-textured cheese would not be expected, because at these pH values the unhydrolyzed paracasein would be insoluble in salt solution. The maximum smoothness should be obtained in the region of pH 5.5 and 6.0, because in this region the paracasein is peptized by salt. Unsalted cheese, however, should not be smooth in this pH region, unless it is overripened.

Davel and Retief (4) concluded that the control of the acidity was the most important factor in the manufacture of processed cheese. The pH-body curves for processed cheese as given by Templeton and Sommer (12) are in agreement with the idea that cheese would be poor in texture at pH zones 5 and 7, and smooth at pH 5.5 to 6.0. Watson (19), Brown and Price (3), and others have shown that in cheese making the pH falls during the first day or two to the region of pH 5 or below, and then during the true ripening the pH very slowly increases and again enters the region (pH 5.5 to 6.0) of maximum dispersion of the paracasein by salt. The pH values

of cheese given by Knudson (6) and Wode (20) fall in the peptizing zone. A number of samples of commercial processed cheese were examined and were found to have pH values from 5.45 to 6.0. These values are in agreement with those published by Templeton and Sommer (11) (12).

This investigation, together with the available literature, has led to the development of the idea that 6 more or less independent factors are involved in producing a smooth processed cheese. (1) The temperature and condition of heating; (2) the composition of the cheese; water, fat and casein-water ratio; (3) the degree of ripening or actual breakdown of the paracasein; (4) the proper pH zone, which, although influenced by the degree of ripening and salts present, should be within the limits 5.5 to 6.0, the zone of maximum peptization of the paracasein; (5) the presence of a salt which acts to reduce the calcium ion concentration or to remove calcium from the paracasein (phosphates, citrates, tartrates, carbonates); (6) The presence of a salt which acts as a paracasein peptizer. This effect may be aided or hindered by the salt added to control the calcium. One salt may be added to control the calcium and another quite different one may accomplish the peptization. The milk salts retained in the cheese, as well as the added sodium chloride influence the peptization.

SUMMARY

The pH precipitation zone of paracasein is much wider than that of casein.

Sodium fluoride, chloride and iodide increased the alkaline solubility zone of casein, but sodium iodide and chloride restricted the alkaline solubility zone of paracasein. Sodium fluoride showed an anomalous behavior with paracasein which is related to its plasticising action associated with the precipitation of calcium.

Paracasein in the presence of a suitable concentration of sodium chloride shows solubility zones at pH 2.5, 6.0, and 9.5, and zones of insolubility at pH 1.0, 4.5, and 7.0-9.0.

The texture of cheddar cheese is effected favorably by the peptizing action of sodium chloride on paracasein in the pH zone between 5.5 and 6.0.

The following factors influence the body and texture of processed cheese: (1) Conditions of heating; (2) Composition; (3) Degree of ripening; (4) pH zone; (5) Removal of calcium from paracasein; (6) Peptization of the paracasein.

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VITAMIN A ACTIVITY OF THIRD CUTTING ALFALFA HAY AS AFFECTED BY METHODS OF CURING*

ELLA WOODS, F. W. ATKESON, HARRY WELLHOUSEN, AND R. F. JOHNSON
Idaho Agricultural Experiment Station, Moscow, Idaho

Dairymen universally consider good quality alfalfa hay as the best kind of dry roughage for dairy cows. Choice hay has fine stems, a large percentage of leaves, and is deep green in color. In fact, greenness and percentage of leaves are two important factors in grading alfalfa hay (1). Since good quality hay is higher in protein and minerals and is more palatable to live stock than low quality, curing methods which would produce choice hay have been practiced. This study was made to find what effect curing methods as practiced in Idaho had upon the vitamin A value of alfalfa hay.

Hilton, Hauge, and Wilbur (13) have reported that the vitamin A value of butter responds very rapidly to changes in the vitamin A value of the ration fed to the cows, and that under practical feeding conditions butter with high vitamin A value can be produced in the winter by feeding good quality alfalfa or soy bean hay. Gillam, Heilbron, Morton, Bishop, and Drummond (6) obtained similar results when cows were fed grass silage or dried grass in winter.

Hart and Guilbert (7) have shown that vitamin A deficiency may occur in beef cattle under natural range conditions and suggest that the best practical method of correcting the deficiency is to feed green feed or good quality alfalfa hay.

Meigs and Converse (14, 15) reported that cows fed liberal quantities of good quality alfalfa hay without pasture for several consecutive years maintained their health, milk yield, and reproductive capacity. When timothy hay of mediocre or low quality was fed the milk yield was slightly reduced, health and staying power of the cows was impaired, and decidedly less satisfactory reproduction was obtained than when alfalfa was fed. Calves fed whole milk to 30 days of age and skimmilk thereafter to six months did well when fed No. 1 alfalfa hay, but when fed No. 3 timothy

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hay their growth was dependent on the kind of hay from which the whole milk received in the first 30 days had been produced.

Rogers (22) in reporting the work of the Bureau of Dairy Industry, United States Department of Agriculture, states that their results showed that "all the carotene of alfalfa hay is beta-carotene and that the vitamin A activity of the hay is fully accounted for by its beta-carotene content. . . . This carotene ranges from 9 to 10 gamma per gram of dry matter for timothy hay to from 35 to 100 for good alfalfa hay, or to about 1000 for carrots."

This is in accord with the results obtained by Moore (18) when beta-carotene was compared with a vitamin A concentrate. He concluded from the biological activity of each that carotene is utilized in the body of rats as efficiently as preformed vitamin A at levels approaching the minimum dose. He had previously reported (17) that carotene can be utilized by the dairy cow as vitamin A.

Machines for artificial drying of hay direct from the field are being used to a limited extent in order to obtain higher quality hay, particularly in sections where good weather for field curing is uncertain. Hathaway, Davis, and Graves (9) reported that alfalfa artificially dried in an Arnold drier was twice as potent in vitamin A as high quality, olive green, field cured alfalfa hay. Russell (23) found that alfalfa leaves from plants machine dried by artificial heat contained at least seven times as much vitamin A as the leaves from poor quality field-cured hay. Later, Russell, Taylor, and Chichester (24) reported that machine dried alfalfa contained from 2 to 10 times as much vitamin A activity as field cured hay, depending on the length and conditions of exposure in field curing. The carotene content of machine dried alfalfa was not less than that of freshly cut material from the same field. In the field curing process there was a progressive loss of carotene, chiefly during the hours of daylight, amounting to 80 per cent in the first 24 hours.

Hauge and Aitkenhead (11) found that while green color is associated with quality in field cured alfalfa hay, green color is not necessarily an index of vitamin A preservation. Artificial drying at high temperatures was not destructive to vitamin A. They concluded that loss of vitamin A in field cured hay was due to enzyme action rather than to the sun's rays. Machine dried hay did not suffer measurable deterioration in vitamin A after being stored a year.

Smith and Briggs (28) report that compared with the leaves of alfalfa cured in the dark the leaves of alfalfa spread out on the field for 2½ hours (11:15 A. M. to 2 P. M.) lost from 22 to 33 per cent in vitamin A activity. No greater loss occurred when the hay was left 6½ hours, but a 75 per cent loss occurred when it was left over night, and an 84 per cent loss when it was left until noon the second day.

Douglass, Tobiska, and Vail (3) found that when cured in diffused light three cuttings of alfalfa hay in three stages of maturity averaged 34.4 rat units of vitamin A activity per gram. Hay cured in the sun averaged 28 units. The following year third cutting hay under the various curing methods had the following vitamin A values: cured in diffused light, 76 rat units; 1.5 inches rain in swath, 18 units; 1 inch rain in cock, 40; 2 inch rain in cock, 38; and moldy hay, 32. Colorado alfalfa hay was higher in vitamin A activity than samples from an eastern and a southern state.

Bethke and Kick (2) reported that the exposing of alfalfa hay to sun, rain, or dew over a period of several days resulted in a marked loss of vitamin A. Sewell and Cottier (25) compared the vitamin A content of kudzu hay cured by three processes: regular field cured, cured in the cock, and cured in the shade. Although the feeding levels were too low to constitute a Sherman unit, the results indicate that the rank of the hay in vitamin A value was shade cured, cock cured, and sun cured.

Hauge (10) found that the vitamin A value of dried young alfalfa, 10 to 12 inches high, was much higher than that of alfalfa in the bloom stage. He also reported that the vitamin A potency of alfalfa hay was located chiefly in the leaves, and the stems were of low vitamin A value. The report of Fraps and associates (4, 5) showed great variation in the vitamin A values for alfalfa hay and alfalfa products. Meigs, Hartman, and Converse (16) reported 35 rat units of vitamin A in No. 1 alfalfa hay, 7 units in No 3 alfalfa, 3 in No. 1 timothy, and 1 in No. 3 timothy.

Hartman (8) bio-assayed one lot of alfalfa hay and two lots of timothy hay purchased in the market and graded according to the official hay standards. Four lots of alfalfa hay taken from the same plot but cured by different methods were also studied. The following relative potencies were obtained: U. S. No. 1 alfalfa, 100; U. S. No. 2 green alfalfa (cured in barn), 100; U. S. No. 2 alfalfa (cured in cocks), 100; U. S. No. 2 alfalfa (sunlight only), 33; U. S. No. 3 alfalfa (sunlight, rain, and dew), 25; U. S. No. 1 timothy, 10; U. S. No. 2 timothy, 3. He also concluded that the vitamin A content of ground or chopped hay decreases with increasing age.

TABLE I
Grades of hay based on official hay standards

SAMPLE NO.	KIND OF ALFALFA HAY	PER CENT STEMS	PER CENT LEAVES	U. S. GRADE
I	Third cutting, swath cured and sweated	47.9	52.1	U. S. No. 1 Extra Leafy
II	Third cutting, cock cured and sweated	34.2	65.8	U. S. No. 1 Extra Green Extra Leafy
III	Third cutting, cock cured, not sweated	47.2	52.8	U. S. No. 1 Extra Green Extra Leafy

DESCRIPTION OF CURING PROCESSES

The hay used was made from Grimm alfalfa grown under irrigation at the Caldwell Substation of the Idaho Agricultural Experiment Station. It was the first year's hay crop, the alfalfa having been seeded without a nurse crop the previous fall. The samples taken represented third cutting hay from the same field, produced under like conditions except for the method of curing. All the hay was mowed the morning of September 26 and received 0.16 of an inch of rain that day. During the curing, the average daily maximum temperature was 77° F. and the average minimum was 35°. The following is a description of each of the three curing processes.

Alfalfa hay No. 1 (swath cured and sweated in the stack). This hay was cured in the swath three days, then raked and cocked, and left in the cock for five days before it was stacked. It was in the swath during the rain and was bleached when stacked. Samples for biological assay were taken November 23, 49 days after the hay was stacked, by removing the top of the stack and taking samples in various places. Hay No. 1 remained in the swath three days and No. II only a little over one day, just long enough to allow it to dry some. The prevailing practice among farmers of the area is to leave alfalfa in the swath about two days before it is cocked.

Alfalfa hay No. III (cock cured and not stacked). This was the same hay as No. II, but the sample was taken from the cock the day before it was stacked. Hay No. II was sampled after going through the "sweating" process in the stack for 49 days. Because of the rather high moisture content of hay No. III, it was air dried in diffused light before grinding.

Each of the samples was graded according to the United States grading standards (1). Since only the pure alfalfa hay was used in feeding, all foreign material was removed before grading. On this basis the sample of hay No. I graded "U. S. No. 1, Extra Leafy," while the sample of hay No. II and of No. III graded "U. S. No. 1, Extra Green, Extra Leafy" (Table I). Hay No. I did not grade "Extra Green" because it had bleached some in the swath. Samples No. I and No. III contained practically the same percentage of leaves (about 52 per cent), while sample No. II contained 66 per cent leaves. Although hay No. III was not analyzed for moisture, its high moisture content was apparent as it was necessary to air dry the sample before grinding in the laboratory.

Table II shows that samples of hay No. I and No. II analyzed practically the same in moisture (7.2 and 7.1). They were slightly lower than the average of 8.6 reported on 250 samples by Henry and Morrison (12). Since some drying probably took place before analysis the exact moisture content of the samples as taken from the stock is not known. Results from the three samples of hay should be comparable as each sample was air dry when fed. Sample No. I, swath cured, was lower in protein and higher in fiber

than sample No. II, but with only one sample of each hay involved the attributing of this difference to the curing process may be questioned. Both samples were considerably higher in protein (No. I, 16.3 per cent and No. II, 18.5) and lower in fiber (No. I, 25.6 and No. II, 22.2) than the average of 14.9 per cent protein and 28.3 per cent fiber reported by Henry and Morrison (12). This would be expected because of the high grade of the hay, which is partially based on percentage of leaves, and leaves are much higher in protein than stems (Table II).

EXPERIMENTAL PROCEDURE

The method used for determining the vitamin A activity of hay was based upon the technique of Sherman and Munsell (26). Young albino rats, 21 to 26 days old and weighing from 31 to 47 grams, were taken from mothers who had received a ration consisting of 30 per cent whole milk powder, 3 per cent powdered egg yolk, 4 per cent wheat germ, 1 per cent iodized salt, and 62 per cent ground whole wheat. The basal vitamin A free diet used consisted of 67 per cent cornstarch, 18 per cent air heated casein, 10 per cent dried yeast powder, 1 per cent sodium chloride, and 4 per cent salt mixture (Osborne and Mendel, 19). The casein was treated according to a modification of Potter's method (21). Vitamin D was furnished by feeding one drop of Mead's Viosterol three times a week.

The usual system of handling the rats in cages prevailed. Each rat was weighed regularly during the depletion period. As soon as there was a cessation of growth or the first sign of ophthalmia appeared, usually accompanied by a tendency to flabby musculature and slightly unkempt fur, the depletion period was ended and the rats were started on the test period with different amounts of hay or hay products as vitamin A supplements. When the hay samples were received at the laboratory sub-samples of whole hay, leaves, and stems were taken and each ground very finely in a laboratory power mill. These sub-samples were stored in closed Economy fruit jars away from heat and light.

Doses were weighed and fed three times a week. Litter mates of essentially the same weight were placed in each of the groups under comparison and in the negative control group. Weekly records were kept of body weight and food consumption, and notes were made on the condition of each rat. The method of eye scoring was that used by Steenbock and Wirick (29). Each rat was autopsied at death or at the end of the eight weeks' test period.

Three series of feeding tests were conducted and will be referred to as the fall series, the winter series, and the spring series. The fall series represented a comparison of the whole hay, leaves, and stems of hay No. III (cock cured and not sweated in the stack). This hay sample, which was the first to arrive at the laboratory, was received October 5. The first rats were

TABLE II
Chemical composition of third cutting alfalfa hay, stems, and leaves

SAMPLE NO.	CURING METHOD	DESCRIP- TION	MOISTURE	ASH	CRUDE PROTEIN	CRUDE FAT	CRUDE FIBER	NITROGEN- FREE EXTRACT	CALCIUM	PHOS- PHORUS
I	Third cutting, cured in swath and sweated	Whole Alfalfa	7.1 0	8.9 9.5	16.3 17.5	1.5 1.6	25.6 27.6	40.6 43.8	1.420 1.530	.211 .227
		Stems	7.0 0	6.8 7.3	9.9 10.7	1.0 1.1	35.5 38.2	39.8 42.7	.850 .915	.149 .160
		Leaves	6.8 0	13.5 14.5	22.3 24.0	2.0 2.2	12.9 13.9	42.5 45.4	2.290 2.460	.240 .258
II	Third cutting, cured in cock and sweated	Whole Alfalfa	7.2 0	8.7 9.4	18.5 19.9	1.9 2.2	22.2 23.8	41.5 44.7	1.590 1.710	.209 .225
		Stems	6.9 0	7.0 7.6	12.2 13.1	1.1 1.2	36.3 39.0	36.36 39.1	.850 .914	.162 .174
		Leaves	7.4 0	12.5 13.5	24.1 26.0	2.4 2.6	12.0 12.9	41.6 45.1	2.130 2.300	.234 .296

Note: Chemical analyses made by the Department of Agricultural Chemistry, Idaho Agricultural Experiment Station.

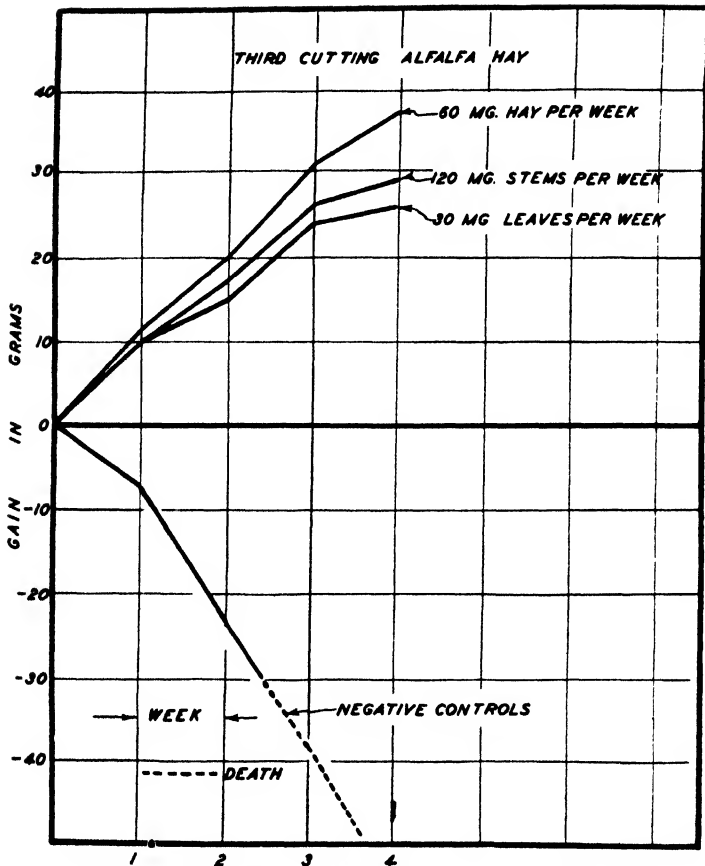


Fig. 1. Average weekly weight increases of rats, previously depleted of vitamin A, when fed either whole hay, stems, or leaves of third cutting alfalfa.

The rat units were calculated from a total average gain of 3 grams per week. Average weekly losses in weight of negative control rats were computed each week by averaging the weight of all living rats as long as 50 per cent of the original group survived. The line was terminated by extending it directly from the last week showing 50 per cent survival to a point indicating the average survival days and average weight at death for the entire group. The broken line indicates that one or more deaths occurred during the week.

started on feed October 6 and the last rats November 7. The test was completed January 3. Thirty-nine rats were divided into four groups as follows: 11 fed 60 milligrams of whole hay per week, 11 fed 120 milligrams of stems, 11 fed 30 milligrams of leaves, and 6 were kept as negative controls.

The winter series represented a similar study of hay No. 1 (swath cured and sweated in the stack) fed at the same levels as in the fall series. The

sample arrived November 23, and the first rats were started on feed December 14 and the last rats February 5. All the rats completed the eight weeks' test period on or before April 2. These levels were too low to induce gains with hay cured in this manner. Only 2 of the 16 rats represented in the three groups lived the entire eight weeks. At the end of the first four weeks only 3 of the 16 rats were alive and at maximum weight up to date. Another group was then fed whole hay at a level of 90 milligrams per week, a 50 per cent increase, but the level was too low to induce gains. All the rats died before the end of the eight weeks' period, and only two of the six were alive at the end of the fourth week. All the rats in these four groups showed typical symptoms of vitamin A deficiency.

In the spring series of feeding tests whole hay samples of hay numbers I, II, and III were compared to determine the effect of the respective curing processes on the vitamin A acidity. Hay No. I was fed to 10 rats at a level of 120 milligrams per week, hay No. II to 10 rats at 90 milligrams, and hay No. III to 9 rats at 60 milligrams. The doses of hay No. I, swath cured and sweated in the stack, were increased to 120 milligrams per week because in the winter series of feeding tests the level of 90 milligrams was too low to induce gain. The first rats were started on feed February 5 and the last April 7. The test was completed on June 2. The samples of hay No. I and hay No. II had been in the laboratory 74 days when the first rats were started, and sample of hay No. III had been in the laboratory 123 days.

The six groups of rats were quite similar in average weight at the beginning of the depletion period and also at the end (Table III). The average weight of the groups at the beginning varied from 37 to 40 grams, and the average weight at the end of depletion varied from 103 to 116 grams.

The vitamin A values are interpreted from the gains made in the first four weeks although gains for the entire eight weeks are included. In analyzing the results of the first four weeks, the method prescribed for the standardization of cod liver oil by the United States Pharmacopoeia (20) has been considered. The data do not conform in all particulars with these specifications, and there are no results from a group on "Reference oil" so that interpretation can not be made in International Units of Vitamin A. The unit of value used in this paper is the amount which will cause a total average gain of 12 grams in four weeks. Groups of not less than six rats, which represent at least two-thirds of the rats fed, are used in summarizing the results for the 4-week period. For interpretation of the results based on the 8-week period, all animals, even those which died during the test period, are included in the averages.

DISCUSSION OF RESULTS

In 4 of the 6 groups, the coefficient of variation for gains made in four weeks was less than for gains made in eight weeks. Also, the coefficients for

TABLE III
Average growth *in* pounds of rats when fed third cutting alfalfa hay

SAMPLING TREATMENT NO	CURING PROCESS	DATES OF TRIALS	AMOUNT PLANT FED WEEKLY	FOUR WEEKS TEST PERIOD										EIGHT WEEKS TEST PERIOD																																																																																																																																																																																																																																								
				RATS USED	RATS USED	RAT WT. IN TEST PERIOD	RAT WT. IN TEST PERIOD	AVG WT. IN 4 WEEKS	AVG WT. IN 4 WEEKS	COEFFI CIENT OF VARIATION	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN A	RAT UNIT VITAMIN

the six groups were more similar at the fourth week, varying from 20 per cent for the lowest to 33 for the highest. The coefficients of variation in these feeding tests were smaller than Sherman and Burtis (27) report may usually be found. The discussion of results will be limited to vitamin A values determined at the end of the first four weeks of each feeding period.

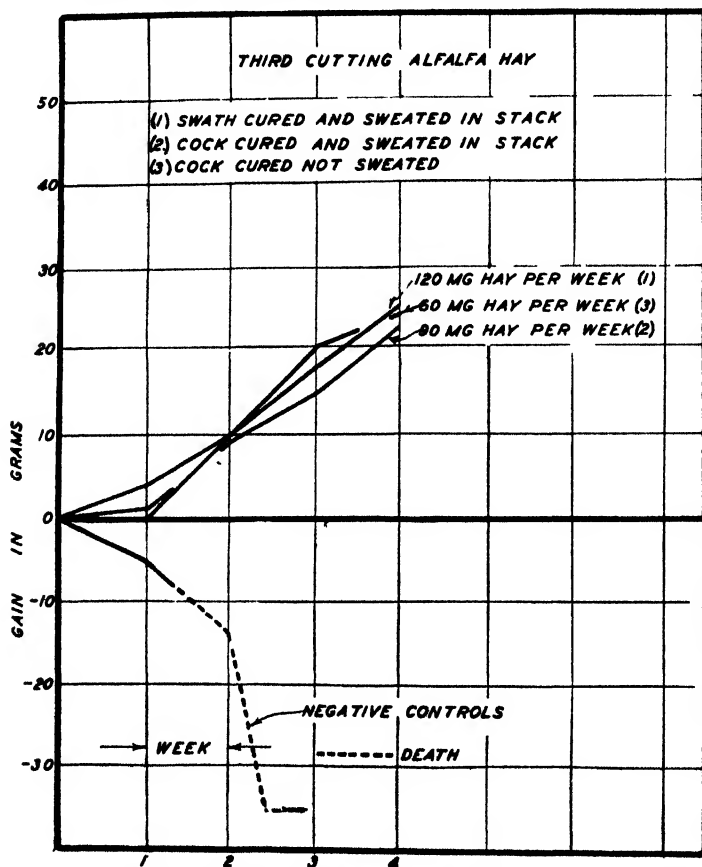


FIG. 2 Average weekly weight increases of rats, previously depleted of vitamin A, when fed third cutting alfalfa hay cured by different methods.

Statistical analysis of the results showed significant differences among the vitamin A values of hay, leaves, and stems, the difference between whole hay and leaves being seven times the probable error of the difference, and between whole hay and stems the difference about 19 times the probable error. The alfalfa hay leaves (483 ± 34 units) contained four times as much vitamin A activity per gram as stems (121 ± 7 units). The grade on

this sample of hay showed 53 per cent leaves and 47 per cent stems. The vitamin A value of the whole hay, computed from the vitamin A value of stems and leaves and the percentage of each, should be 302 rat units. This

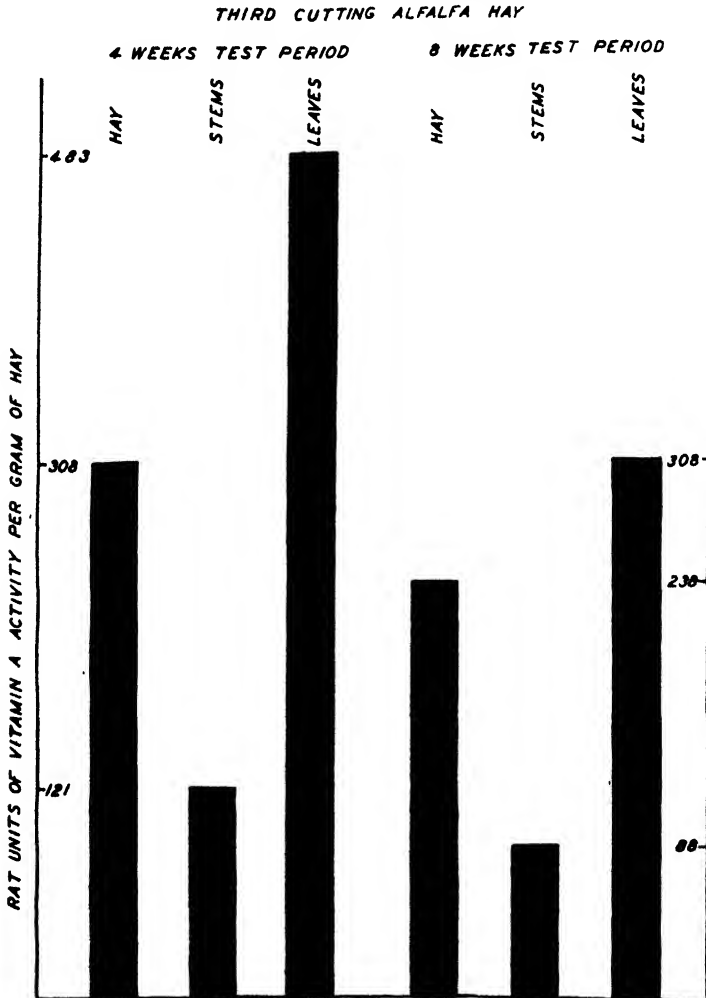


FIG. 3. Rat units of vitamin A activity per gram of whole hay, stems, and leaves of third cutting alfalfa. The rat units were calculated from a total average gain of 2 grams per week. Results are shown for test periods of both 4 and 8 weeks.

is in close agreement with the results found, 308 ± 13 units. In this sample, which was exceptionally high quality hay, about 85 per cent of the vitamin A activity was in the leaves.

When the same whole hay was bio-assayed after being kept in ground form at room temperature and in diffused light for about four months the vitamin A value was 233 ± 20 rat units per gram. This is a reduction of about 24 per cent from the value of 308 ± 13 units obtained soon after har-

THIRD CUTTING ALFALFA HAY

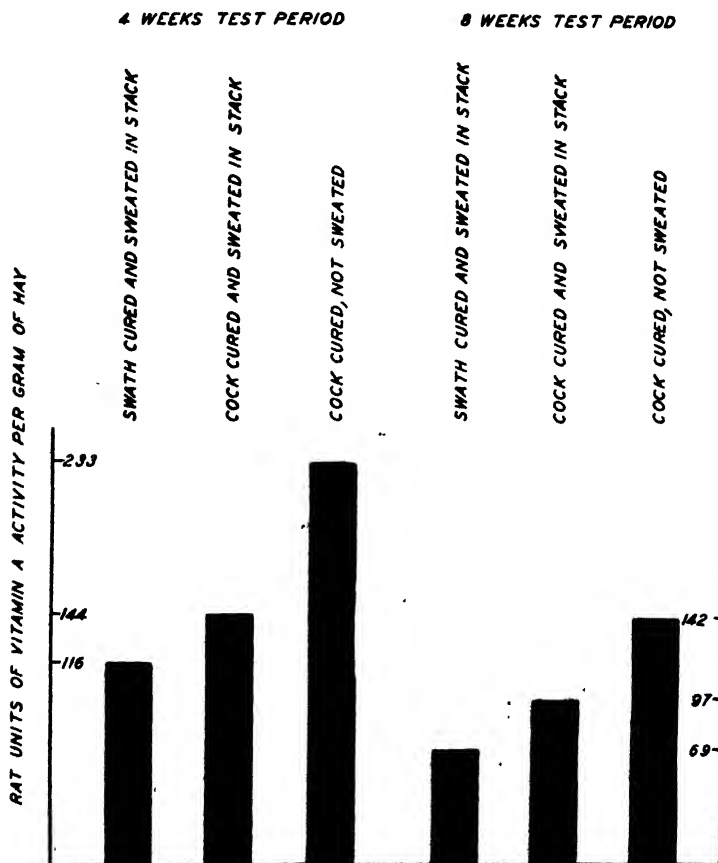


FIG. 4. Rat units of vitamin A activity per gram of third cutting alfalfa hay cured by different methods.

vesting. These results are in agreement with the reports of Hartman (8). Although it would be of practical interest, it is impossible to conclude from this investigation how much loss of vitamin A activity might be expected from storage after hay has gone through the "sweat" and is stored in the stack or bale for various periods of time.

Comparison of swath-curing with cock-curing was made on samples which had been kept in the laboratory for $2\frac{1}{2}$ to 3 months, which probably resulted in lower vitamin A values than would have been obtained on fresher samples. Direct comparison was possible, however, as each hay had been stacked 49 days, the only difference being that hay No. II laid in the swath only one day and curing was completed in the cock, while hay No. I laid in the swath two additional days before being cocked. Hay No. I, which is referred to in this article as swath cured, contained 116 ± 9 rat units of vitamin A activity per gram while hay No. II, cock cured, contained 144 ± 10 units. Thus, the two extra days of exposure in the swath caused a loss of about one-fifth of the vitamin A activity. These results are in harmony with those of Smith and Briggs (28) who found continued loss of vitamin A in alfalfa hay when exposed in the swath from a few hours to one week. Statistical analysis, however, shows that the difference of 28 rat units between swath cured and cock cured hay is not very significant, being only slightly greater than three times the probable error of the difference ($3 \times 9 = 27$).

Hay that had been sweated, however, showed a significant difference from hay not stacked (both cock cured). The hay which was sweated in the stack contained 144 ± 10 rat units of vitamin A activity per gram, while the hay which was not sweated contained 233 ± 20 units, or a difference of 87 units. This would indicate a reduction of about one-third in vitamin A value due to the sweating process. The probable error of the difference was 15. Thus the difference was about six times the probable error.

In the sweating process considerable heat is generated, and the hay remains damp for some time due to respiration of the plant tissues. These conditions would seem favorable to oxidation and enzyme action, whereas, the hay sampled before stacking was air dried a few days after sampling, which would tend to check enzyme action.

The results of these feeding tests indicate that in order to produce alfalfa hay with high vitamin A value, curing methods which will preserve the green color and prevent shattering of leaves should be used. Fortunately such methods also result in high percentages of protein and minerals and maximum palatability. The official hay standards (1) require that U. S. No. I alfalfa hay shall contain 40 per cent or more of leaves and 60 per cent or more of green color, while U. S. No. II hay shall contain 25 per cent or more of leaves and 35 per cent or more of green color. The fact that two of the samples studied contained 52 per cent of leaves and the other sample 66 per cent and also that two of the three samples graded "extra green" would indicate that the hay fed was of exceptionally high quality. This would account for the high vitamin A values obtained in these feeding tests compared with those obtained in areas where weather conditions are more hazardous for curing. The exceptionally high quality of hay from the

irrigated areas of the western states is generally recognized by livestock men.

Under reasonably good methods, as practiced in these areas, alfalfa hay might be expected to contain 100 or more rat units of vitamin A activity per gram. This would be a potent source of vitamin A for winter feeding of dairy cows and should result in dairy products with high vitamin A values. Fresh green alfalfa samples under pasturage condition has been reported as containing 269 ± 17 rat units per gram (32). Under similar conditions other pasture plants have been found to be high in vitamin A activity (30, 31, 33). Because of the difference in the moisture content of hay and pasture plants as fed, the vitamin A activity per gram of dry matter would be much higher in pasture plants than in alfalfa hay of high quality. Another fact worthy of consideration is that dairy cows normally consume from 3 to 5 times as many pounds of pasture plants daily as they do of alfalfa hay, thereby making the daily intake of vitamin A much greater when the cows are on pasture.

CONCLUSIONS

1. The growth response of rats during a four weeks' feeding period indicated that a fresh sample of third cutting alfalfa hay, cock cured and not sweated in the stack, contained 308 ± 13 rat units of vitamin A activity per gram. Leaves and stems of the same hay contained 483 ± 34 and 121 ± 7 rat units respectively. The leaves contained four times as much vitamin A activity as the stems. About 85 per cent of the vitamin A activity of the hay was in the leaves.

2. Another sample of the same hay was bio-assayed after being kept in ground form at room temperature and in diffused light for about four months. The number of rat units of vitamin A activity found was 233 ± 20 , or a reduction, due to storage, of about 24 per cent from the fresher sample of hay, 308 ± 13 units.

3. Comparison of swath curing with cock curing was made with samples $2\frac{1}{2}$ to 3 months old. Third cutting hay cured in the swath three days (swath cured) and then cock cured and sweated in the stack, contained 116 ± 9 rat units of vitamin A activity per gram. The same hay, cured only one day in the swath (cock cured) and then cured in the cock and sweated in the stack, contained 144 ± 10 units. Although one-fifth of the vitamin A activity was lost due to the two additional days curing in the swath, statistically the loss was not very significant.

4. The effect of sweating in the stack on the vitamin A activity of the hay was measured by comparing $2\frac{1}{2}$ to 3 months old hay which was cock cured only with the same hay cock cured and stacked for 49 days. The unsweated hay contained 233 ± 20 rat units of vitamin A activity per gram while the

sweated hay contained 144 ± 10 units, or a reduction of about one-third in the vitamin A units, which was a significant reduction, statistically.

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STUDIES ON THE CHEMICAL COMPOSITION OF THE BLOOD OF DAIRY CATTLE

II. THE EFFECT OF PHOSPHORUS INTAKE ON THE CALCIUM AND INORGANIC PHOSPHORUS CONTENT OF WHOLE BLOOD OF DAIRY HEIFERS DURING THE PERIOD OF FIRST GESTATION AND LACTATION*

A. H. VAN LANDINGHAM,¹ H. O. HENDERSON,² AND G. A. BOWLING²

West Virginia Agricultural Experiment Station, Morgantown, W. Va.

In a former publication (11) observations have been reported on the effect of age and phosphorus intake on the calcium and inorganic phosphorus content of whole blood of dairy heifers during the period of growth. It was shown that low phosphorus rations usually caused an immediate lowering of the inorganic phosphorus in the blood. Frequently the blood inorganic phosphorus continued at a low level until the animals were about eighteen or twenty months of age and then rose to approximately the same level as that of normal animals even though there was no increase in the phosphorus intake in proportion to body weight. As indicated by the inorganic phosphorus of the blood the phosphorus requirement for growth of such animals decreases in proportion to body weight as the animals approach maturity.

Huffman and associates (4) have reported the inorganic phosphorus to be low in the blood of heifers fed a basal ration low in phosphorus from three to eighteen months of age. The inorganic phosphorus in the blood during pregnancy, however, was just as high as was that of heifers fed the basal ration supplemented with steam bone meal. There was, nevertheless, a tendency for the inorganic phosphorus in the blood to be slightly subnormal during the terminal months of pregnancy. Meigs, Blatherwick and Cary (6) observed a drop in the phosphorus content of the blood plasma toward the end of pregnancy, a tendency which they considered to be largely independent of the ration and which shows itself most constantly in the inorganic phosphate fraction. They also observed that the inorganic phosphorus is likely to be low in mature cows just after calving, an observation which has been confirmed by Palmer, Cunningham and Eckles (8) and Wilson and Hart (12).

Robinson and Huffman (9) and Godden and Allcroft (1) (3) found in nearly every case that the inorganic phosphorus of the dam was below that

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1. ² Department of Agricultural Chemistry and Dairy Husbandry, respectively.

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of the calf at birth. A short time before parturition there was a lowering of the maternal inorganic phosphorus which returned to normal at about the end of the first week following calving.

Meigs, Blatherwick and Cary (6) found that the phosphatides of plasma show a marked tendency to rise during the first months of lactation and to remain high until lactation has ceased. The rise in the phosphatide of the plasma was found to occur when the animal was on a reduced ration and was likely to be accompanied by a fall in the concentration of inorganic phosphate. They reported this phenomena largely independent of the diet, and that it was thought to be connected with the fact that near the beginning of lactation there is a tendency for the body fat to be released from its stores and thrown out into the blood.

Eckles and associates (2) and Huffman and coworkers (4) have obtained data with animals on phosphorus-deficient rations which show in a very striking manner that the strain of milk production causes a decrease in the inorganic phosphorus of the blood.

Meigs, Blatherwick and Cary (6) obtained results which indicate that in cows the calcium content of the plasma is fairly constant and not affected by either pregnancy or lactation. Robinson and Huffman (9) and Godden and Allcroft (1) (3) found that there was a definite lowering of the serum calcium at or within twenty-four hours of parturition followed by an increase during the first week after calving.

EXPERIMENTAL

For this study grade Holstein heifer calves from one to two weeks of age were purchased from dairymen in the community and divided into two groups. One group was fed a normal ration while the other was fed a ration low in phosphorus. The normal group, consisting of six heifers numbers E 35, E 38, E 39, E 40, E 43 and E 44 was fed a ration composed of timothy hay, corn meal, ground oats, wheat bran, and cottonseed meal or corn gluten meal. The calcium and phosphorus were assumed to be present in sufficient amounts, as the ration is representative of those fed under practical farm conditions without any apparent harmful results.

The low phosphorus group, consisting of eight heifers numbers E 36, E 37, E 41, E 45, E 46, E 48, E 51 and E 58 was fed a ration composed of timothy hay, polished rice, corn gluten meal, and beet pulp or wheat flour. This ration was much lower in its phosphorus content than the ration fed the normal group but otherwise was very similar in its nutritive value as shown by chemical analysis.

The timothy hay used would grade as U. S. No. 1 and was fed at the rate of about $1\frac{1}{2}$ pounds per 100 pounds of live weight per day. The remainder of the digestible crude protein and total digestible nutrients

required to meet the average of the Morrison feeding standard for dairy heifers was supplied by the respective grain rations fed each group.

The feeding and care of the animals, as well as growth measurements and records were very similar to those of previous work (11). During the lactation period the heifers were milked twice daily and an accurate record was kept of all milk and butter-fat produced.

The feeds used were sampled and analyzed as in previous work (11) except that the procedure as described by Morris, Nelson and Palmer (7) for the determination of calcium and phosphorus replaced the A. O. A. C. Methods. The milk was sampled at frequent intervals throughout the lactation period and analyzed for calcium and phosphorus by the A. O. A. C. Methods. Samples of blood were collected from all animals and composite samples were analyzed for calcium and inorganic phosphorus as in previous work (11).

Time of Breeding

The heifers were bred when they were about 18 to 20 months of age. However, breeding difficulties were encountered with the heifers in both groups. Four of the animals in the normal group and one in the low phosphorus group failed to drop calves while on experiment. E 35 showed the first sign of oestrus at 19 months of age and was bred at that time. At 30 months of age she did not show any signs of pregnancy neither had she shown any further signs of oestrus. She was removed from experiment and slaughtered. Post-mortem examination revealed undeveloped sex organs similar to a free-martin. E 39 was bred several times but failed to show any signs of pregnancy at 27 months of age when she was removed from experiment and slaughtered. Nevertheless post-mortem examination revealed the presence of a small foetus. E 40, E 43 and E 51 were bred several times but did not conceive before they were 27 to 30 months of age when they were removed from the experiment as non-breeders.

Effect of Low Phosphorus Intake and Gestation on Blood Composition

In Tables 1 and 2 are presented data showing the calcium and inorganic phosphorus content of the whole blood during first gestation and lactation in 4-week periods. In Table 2 are included determinations of inorganic phosphorus made on the blood of 15 animals in various stages of lactation but not regularly on this experiment. These animals were receiving a normal phosphorus ration and were handled in the same manner as the animals regularly on experiment.

It may be seen in Table 1 that the lower level of phosphorus intake, gestation and lactation were without effect on the calcium content of the blood.

The lower level of phosphorus intake as shown in Table 2 did not have any appreciable effect on the inorganic phosphorus of the blood during gesta-

TABLE 1
Calcium in whole blood during the periods of gestation and lactation

NO. OF ANIMAL	MILLIGRAMS OF CALCIUM IN 100 MILLILITERS OF WHOLE BLOOD																			
	Gestation										Lactation									
	4-week periods before parturition										4-week periods after parturition									
	9	8	7	6	5	4	3	2	1		1	2	3	4	5	6	7	8	9	10	11
Low phosphorus ration																				
E 36	7.7	8.3	7.7	8.9	7.3	7.8	8.9	7.4	7.5	7.1	6.7	7.9	7.8	6.9	6.9	7.7	6.8	6.8	9.2	7.9
E 37	*	6.9	7.7	7.2	6.7	8.3	7.3	*	8.1	7.3	7.8	7.7	6.9	6.4	7.8	6.9	6.9	7.6	6.8	6.8
E 41	9.0	7.3	6.3	8.3	7.4	7.8	7.4	6.4	6.2	7.1	7.7	7.8	8.0	7.1	8.4	8.9	7.6	7.6	7.1	7.2
E 45	8.3	6.0	6.9	6.3	6.3	7.4	7.9	7.3	6.5	6.9	7.6	7.4	7.3	8.1	6.5	7.1	6.6	7.4	5.1	7.2
E 46	*	6.4	7.4	6.8	6.9	5.5	7.3	7.4	7.6	6.1	†									
E 48	7.0	7.0	7.0	6.3	6.2	6.9	6.7	7.3	6.7	7.4	6.6	6.6	6.8	**						
Average	8.0	7.0	7.2	7.3	6.8	7.3	7.5	7.2	7.1	7.0	7.3	7.5	7.4	7.1	7.4	7.7	7.0	7.2	7.1	7.3
Normal phosphorus ration																				
E 38	7.1	7.3	6.6	6.2	7.0	6.4	7.9	6.3	8.0	7.6	8.3	7.4	7.1	7.2	7.0	7.8	6.7	8.0	6.7	6.3
E 44	7.2	6.6	6.1	7.5	6.3	7.6	7.1	6.8	6.6	6.7	6.9	7.3	7.8	6.8	6.9	6.7	7.0	6.8		
Average	7.2	7.0	6.4	6.9	6.7	7.0	7.5	6.6	7.3	7.2	7.6	7.4	7.5	7.0	7.0	7.3	6.9	7.2	6.7	6.3

* Sample lost.

** Calcium determinations discontinued.

† Died.

TABLE 2
Inorganic phosphorus in the whole blood during the periods of gestation and lactation

NO. OF ANIMALS	MILLIGRAMS OF INORGANIC PHOSPHORUS IN 100 MILLILITERS OF WHOLE BLOOD																			
	Gestation										Lactation									
	4-week periods before parturition										4-week periods after parturition									
	9	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	9	10	11
Low phosphorus ration																				
E 36	5.1	5.6	5.3	5.3	5.9	5.7	5.6	5.6	5.2	4.2	5.2	4.9	4.8	5.0	3.9	3.0	3.2	3.5	5.5	4.5
E 37	*	6.2	5.6	5.8	5.2	4.9	5.3	5.1	4.9	4.6	4.4	5.3	5.7	5.7	5.1	5.1	5.0	4.9	4.7	5.0
E 41	4.8	5.6	6.7	5.8	6.4	5.7	5.5	6.3	5.5	3.3	4.2	4.9	3.9	3.0	2.9	5.1	4.3	4.6	4.6	4.1
E 45	5.8	6.0	5.6	4.8	5.3	5.0	6.0	4.4	4.9	3.7	3.9	3.7	5.3	5.2	5.1	5.9	5.0	4.8	5.4	
E 46	5.1	5.1	5.4	5.1	4.8	4.8	4.2	4.3	4.1	2.7	††									
E 48	5.1	4.4	4.5	5.1	4.1	5.2	4.5	5.9	4.7	2.9	3.7	2.8	2.9	3.0	3.8	4.9	4.4			
E 58	4.9	5.8	4.5	*	5.1	†														
Average	5.1	5.5	5.4	5.3	5.3	5.2	5.2	5.3	4.9	3.6	4.3	4.3	4.5	4.4	4.2	4.8	4.4	4.5	5.1	4.5
Normal phosphorus ration																				
E 38	5.4	5.2	5.2	5.2	4.7	4.6	4.9	4.9	4.9	4.5	5.4	4.6	5.0	5.0	4.4	4.8	4.9	4.7	4.5	4.0
E 44	6.5	5.7	5.4	5.8	5.3	5.5	4.4	5.0	5.1	4.7	5.5	6.5	5.1	4.6	5.2	4.2	4.8	5.4	4.4	
322**										4.2		4.6								
325**														5.3	4.6	5.0	4.5			
326**															4.3		4.7			
327**														4.4		5.5		5.2		
329**												4.9								
332**																				
334**																				
336**										5.0	6.0	4.8								
337**												6.0		5.7		5.4				
347**																				
349**																				
353**										4.3										
389**										5.5										
390**										5.9										
391**																				
Average	6.0	5.5	5.3	5.5	5.0	5.1	4.7	5.0	5.0	4.9	5.6	5.2	5.1	5.0	4.6	4.9	4.7	4.9	4.5	4.0

* Sample lost.

** Animals not regularly on this experiment.

† Aborted.

†† Died.

TABLE 3
Body weight, age at parturition; average daily consumption of digestible crude protein, total digestible nutrients, calcium, and phosphorus during period of gestation

NO. OF ANIMALS	BODY WEIGHT		AGE AT PARTURITION months	AVERAGE DAILY CONSUMPTION OF—				
	Beginning lbs.	End lbs.		Digest. protein lbs.	Total digest. nutr. lbs.	Ca. gms.	P. gms.	P. per 100 pounds of live weight gms.
Low phosphorus ration								
E 36	900	1300	29	1.58	11.58	22.5	12.7	1.15
E 37	886	1165	27	1.50	11.84	19.3	13.1	1.31
E 41	737	1066	27	1.27	10.04	20.5	11.8	1.31
E 45	780	1025	28	1.28	9.91	19.7	11.5	1.26
E 46	772	1090	26	1.32	9.39	14.6	11.5	1.20
E 48	1104	1339	39	1.21	10.39	20.6	11.8	0.95
E 58	761	*	—	1.23	9.17	14.6	10.4	1.19
Average	841	1164	29	1.40	10.32	18.8	11.8	1.20
Normal phosphorus ration								
E 38	937	1329	27	1.70	13.37	25.4	32.4	2.85
E 44	973	1094	37	1.22	9.78	15.7	24.3	2.40
Average	905	1212	32	1.46	11.58	20.6	28.4	2.65

* Aborted during fifth month of gestation.

tion. Immediately following parturition there was considerable lowering of the inorganic phosphorus in the blood of the animals in both groups. The lowering was much more pronounced in the case of the animals on the low phosphorus ration.

The blood inorganic phosphorus of the animals on the low phosphorus ration was considerably lower than of the animals receiving the normal

TABLE 4
Body weight; average daily calcium and phosphorus intake; average daily milk; phosphorus in milk; food phosphorus per pound of milk; food phosphorus minus milk phosphorus per 1,000 pounds body weight and inorganic phosphorus in whole blood

4-WEEK PERIODS	BODY WEIGHT	AVER. DAILY INTAKE		AVER. DAILY MILK	AVER. DAILY P. IN MILK	FOOD P. IN MILK	FOOD P. MINUS MILK P. PER 1000 LBS. BODY WEIGHT	INORG. P. IN 100 MLS. BLOOD	REMARKS
		Ca.	P.						
E 36	lbs.	gms.	gms.	lbs.	gms.	%	gms.	mg.	
Low P.									
1	1106	21.9	16.6	28.8	12.3	74.1	3.9	4.20	
2	1114	25.2	19.5	30.9	13.2	67.7	5.7	5.19	
3	1070	26.8	23.0	35.4	15.1	65.6	7.4	4.85	
4	1056	26.0	22.5	29.2	12.5	55.6	9.5	4.77	
5	1082	25.3	21.4	27.7	11.8	55.1	8.9	5.03	
6	1060	22.7	18.4	25.5	10.9	59.2	7.1	3.89	Deficient
7	1049	23.0	18.1	24.0	10.2	55.7	7.5	2.98	"
8	1052	24.2	19.7	24.1	10.3	52.3	8.9	3.15	"
9	1054	25.6	19.8	24.1	10.3	52.0	9.0	3.50	"
10	1079	25.9	20.6	23.9	10.2	49.5	9.6	5.55	
11	1071	25.6	19.7	21.9	9.3	47.2	9.7	4.53	
12	1066	25.3	19.2	22.0	9.4	48.9	9.2	4.47	
E 37									
Low P.									
1	1004	18.5	13.8	21.6	9.2	66.8	4.6	4.63	
2	996	19.9	16.5	24.5	10.4	63.0	6.1	4.38	
3	991	18.0	16.4	22.9	9.8	59.7	6.7	4.58	
4	967	16.4	16.4	20.5	8.7	53.1	8.0	5.70	
5	940	18.5	18.3	22.3	9.5	51.9	9.4	5.73	
6	934	18.1	18.2	20.8	8.9	48.9	10.0	5.12	
7	939	18.0	17.5	18.5	7.9	45.2	10.2	5.10	
8	942	17.9	17.1	17.2	7.3	42.7	10.4		
9	948	18.0	16.4	17.9	7.6	46.3	9.3	5.00	
10	907	18.1	15.8	16.0	6.8	43.0	9.9	4.92	
11	951	17.6	15.9	15.0	6.4	40.2	10.0	4.65	
12	933	17.6	15.6	14.5	6.2	39.7	10.1	5.00	
E 41									
Low P.									
1	935	21.2	13.7	24.5	10.4	75.9	3.5	3.33	
2	874	20.0	15.7	22.5	10.9	69.4	5.5	4.20	
3	855	20.2	16.8	22.9	9.8	58.3	8.2	4.86	
4	837	19.7	16.2	20.1	8.6	53.1	9.1	3.87	Deficient
5	837	20.5	15.9	19.9	8.5	53.4	8.8	3.03	"
6	879	20.5	15.7	19.5	8.3	52.8	8.4	2.88	"
7	862	21.2	16.1	16.7	7.1	44.1	10.4	5.12	
8	868	20.1	14.6	14.6	6.2	42.5	9.7	4.29	
9	871	19.7	14.1	12.4	5.3	37.6	10.1	4.64	
10	894	19.3	14.3	9.7	4.1	28.6	11.4	4.55	

TABLE -(Continued)

4-WEEK PERIODS	BODY WEIGHT	AVER. DAILY INTAKE		AVER. DAILY MILK	AVER. DAILY P. IN MILK	FOOD P. IN MILK	FOOD P. MINUS MILK P. PER 1000 LBS. BODY WEIGHT	INORG. P. IN 100 MLS. BLOOD	REMARKS
		Ca.	P.						
E 45	lbs.	gms.	gms.	lbs.	gms.	%	gms.	mg.	
Low P.									
1	920	25.6	15.0	18.4	7.8	52.0	7.8	3.74	Deficient
2	917	27.0	16.6	23.9	10.2	61.5	7.0	3.87	"
3	896	25.3	16.4	22.7	9.7	59.1	8.6	3.69	"
3½	858	26.6	16.9	21.7	9.3	55.0	8.9		
Changed to Normal Phosphorus Ration									
4		24.9	50.3	20.8	8.9	17.7		5.31	
5	868	25.3	51.3	22.5	9.6	18.7	48.0	5.24	
6	847	25.7	52.8	20.5	8.7	16.5	52.1	5.06	
7	856	25.2	51.6	15.2	6.5	12.6	52.7	5.91	
8	870	24.9	49.9	15.5	6.6	13.2	49.8	4.97	
9	895	23.0	33.8	15.1	6.4	18.9	30.6	4.77	
10	893	23.4	33.8	13.7	5.8	17.2	30.5	5.36	
E 48									
Low P.									
1	1137	24.3	14.2	25.1	10.7	75.4	3.1	2.91	Deficient
2	1094	26.1	15.7	29.9	12.8	81.5	2.7	3.71	"
3	1080	25.9	15.9	27.5	11.7	73.5	3.9	2.78	"
4	1046	25.6	16.5	27.3	11.6	70.3	4.7	2.93	"
5	1048	25.1	15.8	24.9	10.6	67.1	5.0	2.97	"
6	1003	24.8	13.8	21.3	9.1	65.9	4.7	3.84	"
7	1023	24.8	15.7	20.0	8.5	54.1	7.0	4.86	
8	1008	24.7	15.5	18.9	8.1	52.3	7.3	4.35	

ration and was subject to much greater fluctuations throughout the lactation period.

Data are presented in Table 3 showing the body weight and the age at parturition for the animals in both groups. The average daily consumption of digestible crude protein, total digestible nutrients, calcium and phosphorus and the phosphorus per 100 pounds of body weight of the animals during the period of gestation are also presented in Table 3.

It is shown in Table 3 that an average daily intake of 11.8 grams (equivalent to 1.2 grams per 100 pounds of body weight) of phosphorus met the requirement for phosphorus as indicated by the inorganic phosphorus of the whole blood of the heifers during the period of first gestation.

Effect of Low Phosphorus Intake and Milk Production on Blood Composition

Data are presented in Table 4 showing the body weight, average daily calcium and phosphorus intake, average daily milk production, phosphorus in the milk, percentage of food phosphorus in the milk, food phosphorus minus the milk phosphorus per 1000 pounds body weight, and the inorganic phosphorus in the blood for the low phosphorus animals during lactation.

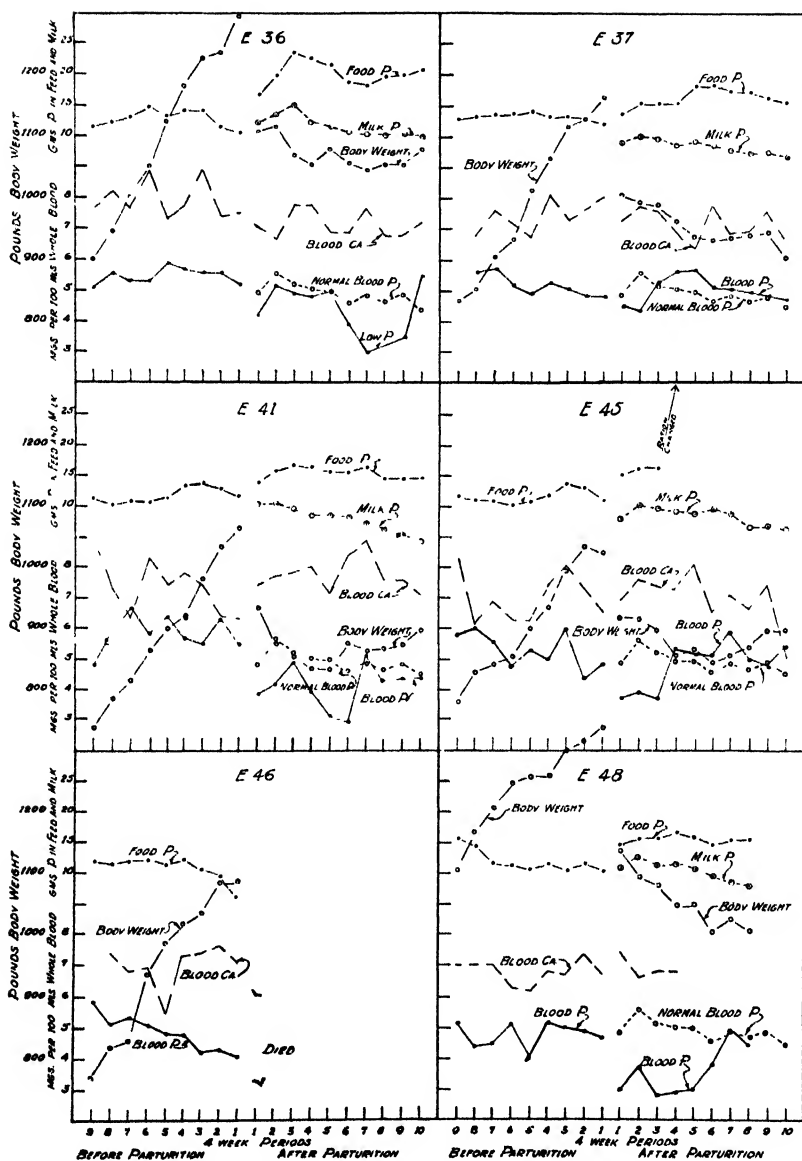


FIG. 1. EFFECT OF THE PHOSPHORUS IN THE FEED, THE PHOSPHORUS IN THE MILK AND THE CHANGE IN BODY WEIGHT ON THE CALCIUM AND INORGANIC PHOSPHORUS CONTENT OF WHOLE BLOOD.

The lower level of phosphorus intake was without effect on the phosphorus content of the milk. The numerical values for the percentage of phosphorus in the samples analyzed were maximum 0.1050, minimum 0.0874, and average 0.0944. The mean value of 0.0944 per cent was used in calculating the average daily phosphorus in the milk.

Figure 1 shows the changes in body weight, phosphorus intake, and calcium and inorganic phosphorus in the blood during gestation and lactation for the animals on the low phosphorus ration. The average values for inorganic phosphorus in the blood of normal animals during lactation as shown in Table 2 are repeated in the figure for comparison. The phosphorus in the milk during lactation is also shown.

DISCUSSION

The physical appearance of the heifers and the data presented in Table 3 indicate that under the conditions of this experiment an average daily intake of 11.8 grams, equivalent to 1.2 grams per 100 pounds of body weight, of phosphorus was sufficient to maintain the inorganic phosphorus content of the blood at approximately the normal level during the period of first gestation. Huffman and associates (4) found that 10 to 12 grams of phosphorus daily furnished sufficient phosphorus for maintenance and growth and for the development of the foetus from 18 months of age to first calving as indicated by the blood phosphorus and the strength and size of the calf at birth.

An average daily intake of 11.8 grams of phosphorus as fed in this experiment apparently did not allow very much in excess of what is actually required to maintain the inorganic phosphorus in the blood, since the drop immediately following parturition was much greater in the case of the animals on the low phosphorus ration. There was also a strong tendency for the heifers on the low phosphorus ration to show anorexia, or loss of appetite and other physical symptoms of phosphorus deficiency associated with a decrease in the inorganic phosphorus of the blood following parturition.

E 58, on the low phosphorus ration, aborted during the fifth month of gestation. E 46, also on the low phosphorus ration, refused a considerable portion of her feed during the last half of gestation. There was a decrease in the inorganic phosphorus of her blood from 5.1 to 4.1 mgs. per 100 mls. of blood preceding parturition. She dropped a dead calf at the end of 270 days' gestation. The calf was presented abnormally and had to be taken. It was very small but appeared normal in conformation. Two days after calving the placenta had to be removed. On the third day after calving the rear quarters of the udder gave bloody milk, but this cleared up in about three days. After calving E 46 continued to refuse a considerable portion of the feed offered and there was also loss in body weight. Her condition

grew worse and about 18 days after calving she was unable to get up. Six samples of blood taken on alternate days following parturition averaged 2.8 mgs. of inorganic phosphorus and 6.4 mgs. of calcium per 100 mls. of whole blood. A sample of blood taken the day before the animal died contained 2.4 mgs. of inorganic phosphorus and 5.4 mgs. of calcium per 100 mls. of blood. There was some indication that the calcium was slightly reduced below normal following parturition. The heifer died on the twentieth day after calving following an injection of about 200 mls. of a 10 per cent solution of calcium gluconate.

The inorganic phosphorus in the blood of the animals on the normal phosphorus ration showed an increase from the first to the second 4-week period following parturition. After the second period following parturition there was a slight decline in the inorganic phosphorus of the blood as lactation progressed. The results obtained with the animals on the low phosphorus ration were rather variable as shown in Figure 1 and Table 4. The data presented show that milk production combined with low phosphorus intake has a considerable effect on the inorganic phosphorus content of the blood. The effect of these two factors is particularly striking in the case of cow E 48, where the excess of feed phosphorus over the milk phosphorus was small, and in E 45, where the ration was changed. It is also shown to some extent in cows E 36 and E 41, but not to any appreciable extent in the case of E 37, where the excess of food phosphorus over the milk phosphorus was too large to produce any very striking results.

It is interesting to note in the case of cows E 36 and E 41 that the phosphorus consumed in the feed in excess of that excreted in the milk was less during the first part of lactation, when the inorganic phosphorus in the blood was about normal, than during the latter part of lactation, when the blood phosphorus showed a deficiency. This may be associated with a removal of phosphorus from the body stores during the early part of lactation. The animals all showed considerable loss in body weight during the first part of lactation and usually small gains during the latter part. There was always a decrease in the percentage of food phosphorus excreted in the milk as lactation progressed.

The data indicate that under the conditions of this experiment about 9 to 10 grams of phosphorus per 1000 pounds of body weight was required in the feed in excess of that excreted in the milk to maintain the inorganic phosphorus in the blood at the normal level.

Rose (10) reported that for maintenance of phosphorus equilibrium the requirement would seem to be the amount of phosphorus eliminated in the milk plus 26 mgs. per kilo body weight (equivalent to 11.8 grams per 1000 pounds body weight.) An excess over this amount caused phosphorus retention, and smaller quantities resulted in loss of phosphorus from the animal.

Ten grams of phosphorus per 1000 pounds of body weight for maintenance as determined by Henneberg and used by Kellner (5) and Huffman and associates (4) compares favorably with the amount found in the present investigation to be required in the feed in excess of that in the milk in order to maintain the inorganic phosphorus of the blood.

Huffman and associates (4) found that the phosphorus requirement for milk production ranged from 0.5 to 0.7 gram of food phosphorus per pound of milk, above maintenance. Ten grams of phosphorus per 1000 pounds of live weight was used for maintenance.

In the present investigation when 10 grams of phosphorus per 1000 pounds of body weight was allowed for maintenance, about 0.4 to 0.5 gram of phosphorus per pound of milk was required to maintain the inorganic phosphorus in the blood. It should be noted that the animals used in this experiment were not heavy milkers, producing only 20 to 30 pounds of milk per day at the peak of production. It is interesting to note also, that in the case of E 45 (Table 4), when the animal was changed from the low phosphorus ration to the normal phosphorus ration, the inorganic phosphorus in the blood rose to the normal level, but there was no increase in the milk produced.

SUMMARY AND CONCLUSIONS

The calcium and inorganic phosphorus content of the whole blood of two groups of Holstein heifers has been studied during the periods of gestation and first lactation. One group was fed a normal phosphorus ration while the other was fed a ration low in phosphorus. Both groups received approximately the same amount of digestible crude protein and total digestible nutrients in proportion to body weight and the amount of milk produced.

From the results obtained under the conditions of the experiment outlined the following conclusions were reached.

1. An average daily intake of 11.8 grams of phosphorus (equivalent to 1.2 grams per 100 pounds of body weight) was sufficient to maintain the inorganic phosphorus in the blood at approximately the normal level during the period of first gestation.
2. There was a decided drop in the inorganic phosphorus of the blood at or immediately following parturition, which was much more pronounced in the case of the animals on the low phosphorus ration.
3. Milk production combined with low phosphorus intake caused a lowering of the inorganic phosphorus content of the blood.
4. The phosphorus in the feed should exceed the phosphorus in the milk by 9 to 10 grams per 1000 pounds body weight in order to maintain the inorganic phosphorus content of the blood for Holstein heifers producing 20 to 30 pounds of milk per day.
5. The lower level of phosphorus intake, gestation, and lactation had no appreciable effect on the calcium content of whole blood.

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ALFALFA SILAGE

W. B. NEVENS AND A. F. KUHLMAN

Department of Dairy Husbandry, University of Illinois, Urbana, Illinois

The desirability of a satisfactory method for preserving alfalfa as silage has long been recognized. Because of the fact that only a part of the attempts to obtain a good grade of silage from alfalfa have been successful, the studies described in this paper were undertaken with the object of trying to solve some of the difficulties involved in the problem. The present paper is a preliminary report of studies now in progress.

HISTORICAL

Many reports of experiments with alfalfa and other legumes as silage crops appear in the literature, but only those which seem to have a direct bearing on the studies reported in this paper are mentioned in this brief review.

Trials have been reported (10, 11, 12, and 13) in which it was found that good quality silage was produced from alfalfa only, while other reports (8 and 14) state that great losses or complete failures occurred when alfalfa was ensiled alone. Allowing the alfalfa to wilt before ensiling was found successful by several investigators (3, 4, 10, and 12), while others (1 and 13) point out that it should be ensiled before it has wilted much. It is stated in several reports (1, 2, 5, 6, 11, and 12) that mixing molasses with the alfalfa as it is ensiled proves effective in increasing either or both the palatability and keeping qualities of the silage. Another report (9) describes successful results with mineral acids as preservatives. Mixing green alfalfa with freshly-harvested sugar-containing crops such as corn, sorghum, kafir, green rye, and mixing with corn meal have also been reported (6, 11, and 12) as effective methods of making good silage. Investigations (7 and 8) of the kinds and amounts of acid present in alfalfa silage led to the conclusion that the acid fermentation of alfalfa silage is dissimilar to that of corn silage and that alfalfa silage is unfit for feeding unless fed soon after ensiling.

EXPERIMENTAL METHODS

Series A.—Cylindrical, galvanized-iron cans about 9 inches in diameter and 27 inches deep were used as silos. The capacity of each was about 37 pounds of chopped alfalfa. The alfalfa consisted of young, new growth crop following three harvests earlier in the season. There was a very small admixture of weeds. It was harvested with a field mower on September 10, 1935, taken from the field at once, and chopped into short lengths by a

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power cutter. The corn which was mixed with the alfalfa in filling two of the silos was at an early stage of development for silage purposes. It also was chopped. Random samples of both crops were taken for analysis.

TABLE 1

Effect of the addition of preservatives to alfalfa at time of ensiling on keeping qualities and acidity of the silage

SILO NO.	PRESERVATIVES ADDED AT TIME OF ENSILING	DRY MATTER IN ALFALFA AS ENSILED	DRY MATTER IN SILAGE AS REMOVED	RECOVERY OF GOOD SILAGE ¹	ACID CONTENT OF SILAGE	
					Fresh basis ²	Dry matter basis ³
<i>per cent per cent per cent per cent per cent</i>						
<i>Series A</i>						
2	None	25	24	77	1.11	4.63
3	Whey powder, 1 per cent	25	25	75	1.36	5.44
4	Whey powder, 2 per cent	25	26	74	1.66	6.38
5	Whey powder, 3 per cent	25	26	79	1.81	6.96
6	Whey powder, 4 per cent	25	26	77	1.71	6.58
7	Whey powder, 5 per cent	25	27	76	1.91	7.07
8	Alfalfa $\frac{1}{3}$, chopped corn $\frac{2}{3}$	24 ⁴	24	75	1.61	6.71
9	Alfalfa $\frac{1}{3}$, chopped corn $\frac{2}{3}$	24 ⁴	24	77	1.66	6.92
10	None	32	32	76	1.16	3.63
11	Molasses, 1 per cent	32	31	74	1.21	3.90
12	Molasses, 2 per cent	32	32	71	1.26	3.94
13	Molasses, 3 per cent	32	33	71	1.17	3.55
14	Molasses, 4 per cent	32	33	70	1.41	4.27
15	Molasses, 5 per cent	32	33	75	1.54	4.67
<i>Series B</i>						
16	Water, 3 per cent	23	23	73	1.11	4.83
17	Water, 2 per cent, lactic acid starter, 1 per cent	23	23	73	1.46	6.35
18	Water, 1 per cent, lactic acid starter, 3 per cent	23	23	74	1.41	6.13
19	Water, 2 per cent, Bulgar-lac 1 per cent	23	23	68	1.26	5.48
20	Water, 1 per cent, Bulgar-lac 3 per cent	23	23	77	1.31	5.70
<i>Series C</i>						
21	Water, 5 per cent	27	24	59	.96	4.00
22	Water, 4.25 per cent, molasses .75 per cent	27	23	60	1.00	4.35
23	Water, 3.5 per cent, molasses 1.5 per cent	27	25	71	.88	3.52
24	Water, 2 per cent, molasses 3.0 per cent	27	28	54	1.11	3.96
<i>Series D</i>						
25	Water, 1.5 per cent, molasses, 3 per cent	39	39	70	1.45	3.72
26	Water, 3 per cent, molasses, 1.5 per cent	39	36	80	1.32	3.67
27	Water, 4.5 per cent	39	35	83	1.31	3.74

¹ In percentage of weight of crop as ensiled plus any water or preservatives added.

² In terms of cc. 0.1 N NaOH per gram of silage, fresh basis.

³ In terms of cc. 0.1 N NaOH per gram of dry matter in silage.

⁴ Dry matter in alfalfa 24.7 per cent, in corn 23.7 per cent.

Whey dried to a powder and blackstrap cane feeding molasses (61 per cent dry matter) were used as sources of fermentible sugars for preservation by produced acids (table 1). Mixing of weighed amounts was done by hand in a large metal tub. The silos were filled by hand while a helper tamped the material solid. Coverings consisted of a layer of slater's felt, and circular boards which fitted loosely inside the silos. Bricks were added to provide a weight of about 25 pounds to the square foot.

Series B.—Galvanized-iron garbage cans having a capacity of about 75 pounds cut alfalfa were used as silos. The alfalfa which was harvested October 3, 1935, was more mature than that used in Series A, and was admixed with about 21 per cent weeds, mostly crab grass. Cutting was done with a power cutter. Random samples of the cut material were taken for analysis. Filling was done by hand, the preservatives being sprinkled over the cut material as it was placed in the silos. The material was compacted by tramping. The preservatives used were lactic acid starter and Bulgarian culture,¹ both prepared fresh for the purpose and incubated at proper temperatures until used. Coverings consisted of slater's felt, circular board covers, and sacks of agricultural limestone sufficient to provide a total weight of covering equivalent to approximately 25 pounds to the square foot.

Series C.—Equipment, materials and procedure were the same in this series as in Series B, with two exceptions. The alfalfa was ensiled unchopped, that is, it was ensiled "whole" just as harvested with a field mower, and different preservatives were used than in Series B. The amount of alfalfa placed in each silo was 65 pounds. It could not be compacted as closely as the chopped alfalfa.

Series D.—The silos used in this series consisted of wood stave tanks 4 feet in diameter and 10 feet deep. Materials, methods, time of filling, etc., were the same as in Series B, except that different preservatives were used and these were thoroughly mixed with the cut alfalfa by means of shovels before the material was ensiled. From 700 to 1,000 pounds of cut alfalfa were placed in each silo.

General Procedure.—All the silos (Series A, B, C and D) were stored in a barn. Those used in Series B and C were surrounded with shavings to reduce heat losses.

The silos in Series A, B, and C were opened December 21, 1935, and the silage weighed and sampled. The three silos of Series D were opened January 9, 1936, January 18, 1936, and February 12, 1936, respectively. The spoiled silage was removed from each silo by hand and decision as to the dividing line between spoiled and good silage was made by the aid of visual estimates and odor only. The silage in the three silos of Series D was fed to two Holstein cows, one producing upwards of 30 pounds milk daily and

¹ A skim milk culture of *B. bulgaricus*.

the other more than 50 pounds daily. Alfalfa silage was substituted gradually for corn silage in the rations of the two cows until the level of feeding reached 25 to 30 pounds of alfalfa silage daily.

The procedure for determination of water-soluble acidity outlined by the Association of Official Agricultural Chemists was followed except for certain modifications. The method used follows: To a 100-gram sample of silage, 500 cc. of freshly boiled distilled water and 1 cc. formalin solution were added. The stoppered flasks were shaken for 15 minutes on a shaking machine. After filtering, 50 cc. of the filtrate were made up to 500 cc. in a graduated flask. A 100 cc. portion, equivalent to 2 grams of sample, was titrated with 0.1 N NaOH, using phenolphthalein indicator.

DISCUSSION OF RESULTS

Series A.—All of the alfalfa ensiled in Series A produced silage having a pungent acid odor, pleasant aroma and dark green color. But little difference in these qualities could be detected in the fourteen lots of silage in this series. The recovery of good silage from the various silos (Table 1) showed no significant differences and hence no advantages in this respect for the addition of the preservatives. The use of the whey powder and molasses apparently caused an increase in acid content of the silage and presumably this would be a desirable factor in silage which is to be kept over a long period, particularly during hot weather. A higher acid content was produced with the larger amounts of preservative but the determinations did not show a uniform increase.

Small amounts of silage from a number of silos in Series A were eaten eagerly by cows not fed alfalfa silage previously.

Series B.—The silage removed from the silos of Series B was similar to that in Series A in percentage recovery and qualities of the silage. The use of the lactic acid and Bulgarlac cultures evidently caused an increase in acid content but no relation between amounts of preservatives added and the acid content of the silage was found.

Series C.—The whole (unchopped) alfalfa ensiled in this series of experiments did not keep quite as well as the chopped alfalfa in the other series. This was attributed to the difficulty experienced in packing the whole alfalfa closely to the corrugated sides of the silos. Some mold was found next to the walls below the line of demarcation of the spoiled surface layer. The silage in the centers of the silos appeared excellent, however. It is reasonable to assume, upon the basis of the results obtained, that whole alfalfa properly packed in a suitable container will make silage of good quality.

No definite conclusions with regard to the use of molasses as a preservative can be drawn from this series of experiments on account of the poorer keeping conditions of the silage.

Series D—The silage in this series of experiments was not as green in color as that in the other series and resembled dampened hay. It is assumed on the basis of appearance, keeping quality and palatability that the dry matter content of this lot of alfalfa at the time of ensiling, namely 39 per cent, is about the upper limit at which alfalfa ensiled without preservatives will keep satisfactorily.

The mixing of molasses with the alfalfa at the time of ensiling produced a more palatable silage than the ensiling of alfalfa alone, as judged by feeding tests with the silage from each of the three silos in this series. The silage from Silos 25 and 26, in which molasses was used at the rates of 3 per cent and 1.5 per cent, respectively, of the weights of the alfalfa, was eaten with great relish, but that from Silo 27 to which no preservative other than water was added was not eaten as readily.

Alfalfa silage was gradually substituted for corn silage during one week and the cows were then fed alfalfa silage (together with alfalfa hay and a grain mixture) continuously for approximately six weeks. Comparison of the production during the two weeks preceding and the two weeks following the alfalfa silage feeding failed to reveal any noticeable effect of the alfalfa silage feeding upon productivity of the cows (Table 2).

TABLE 2
Production of Holstein cows fed alfalfa silage

WEEK ENDING (1936)	YIELD OF FAT-CORRECTED MILK (F.C.M.) ¹	
	Cow 416	Cow 553
	pounds	pounds
<i>Preliminary period-corn silage</i>		
January 3	350	250
" 10	347	242
<i>Alfalfa silage period</i>		
January 17	373	249
" 24	375	247
" 31	353	245
February 7	335	249
" 14	334	232
" 21	331	219
" 28	338	236
<i>Subsequent period-corn silage</i>		
March 6	303	208
" 13	320	205

¹ Milk yield corrected to an energy equivalent basis of 4 per cent milk by application of the Gaines formula: F. C. M. = $0.4 \times$ milk in pounds + $15 \times$ fat in pounds.

The feeding of alfalfa silage induced a very laxative condition in the two cows, leading to the conclusion that alfalfa silage is more laxative in its

effects than corn silage, although no measurements of the softness of the feces were made.

SUMMARY AND CONCLUSIONS

Alfalfa was ensiled in twenty-three small metal silos and three wooden tanks. It was found that small cylindrical metal containers may be used satisfactorily in experimental studies of silage.

Whey powder mixed with the alfalfa at the time of ensiling at the rates of 1, 2, 3, 4, and 5 per cent, respectively, of the weights of the alfalfa caused an increase in the acid content of the silage over that of alfalfa ensiled alone, and in most cases the larger amounts of powder produced a more acid silage. Blackstrap cane feeding molasses, lactic acid starter, and Bulgarlac culture incorporated with the alfalfa at the time of ensiling also caused some increases in the acidity of the silage. The whey powder seemed to be the most effective of the preservatives used in causing an increase in the acid content.

A good quality of silage resulted from the mixing of chopped green corn harvested at an early silage stage with chopped alfalfa.

Alfalfa ensiled whole (unchopped) did not keep as well as chopped alfalfa, but it is believed that when ensiled under suitable conditions, whole alfalfa may readily be preserved as silage.

Different lots of alfalfa having dry matter contents at the time of ensiling of 23 per cent, 25 per cent, 27 per cent, 32 per cent, and 39 per cent, respectively, which were ensiled without preservatives except for a very small amount of water, yielded silage having good keeping qualities. It is concluded on the basis of these trials that a dry matter content of 39 per cent is about the upper limit for the successful ensiling of alfalfa alone.

Alfalfa silage is a very palatable feed for dairy cows and when fed in limited amounts has a feeding value comparable with that of corn silage, but has a laxative effect greater than that of corn silage.

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SEASONAL VARIATION IN THE BIRTH RATE OF THE MILKING GOAT IN THE UNITED STATES*

C. W. TURNER

Department of Dairy Husbandry, University of Missouri, Columbia, Missouri

Normal sexually mature non-pregnant dairy cows pass through regular estrus cycles throughout all seasons of the year. It is possible, therefore, to breed cows to calve whenever desired. This is a very desirable characteristic of cattle, as it makes possible the production of a fairly uniform milk supply or permits breeding cows for fall calving where that practice is indicated.

The dairy goat, in common with most breeds of sheep, appears to differ in this respect from cattle. Shaw (4) reported from observations of the goat herd of the U. S. Department of Agriculture that does come into heat at all times of the year, but not frequently between the first of March and the middle of August.

In an extensive study of the season of conception of milk goats in Great Britain, Asdell (1) observed a gradual increase in the rate of conception from August to October, followed by a gradual decline reaching a minimum in May. The number of conceptions during the four months, April May, June and July was very small. Evidence was presented suggesting that a cool summer produced early estrus while a hot summer had the opposite effect.

Kupfer (3) studied the periodicity of the ovarian changes of the goat both in Switzerland and in South Africa. In Europe ovulation was definitely observed during the months of October, November and December. The season was believed to extend into adjoining months under certain circumstances. Ovulation was reported to recur at regular three weeks' intervals. There then follows a period of reduced ovarian activity. Ovulation is entirely suppressed during this time. It was emphasized that in the sexual functions of the goat a long period of rest alternates with a period of ovarian activity.

Observations were also reported upon the Boer goat of South Africa. These goats also were seasonal breeders. The season of ovarian activity probably extends from April to August during the winter with ovulations at intervals of about three weeks. In the spring and summer, from September to February, or March ovulations are held in abeyance.

The sexual activity of goats in the Philippine Islands has been studied by Villegas (5). The month of conception and of parturition in 103 mat-

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ings were tabulated. Two sexual seasons were observed, the first during May and June and the second in November. Over 30 per cent of the matings occurred in the two spring months and over 40 per cent in the four months from November to February. It is interesting to note that sheep had practically the same sexual and reproductive seasons as goats.

These studies indicate considerable variation in the sexual activity of dairy goats in various countries under varying climatic conditions. Due to an interest in the goat as an experimental animal in connection with studies concerned with the hormone control of milk secretion, it became of interest to learn more of the reproductive process in this animal.

The object of the present paper is to report the results of a study to determine the duration of the fertile season in the goat under conditions in the United States. Through the kindness of Dr. A. J. Durant, of the Department of Veterinary Science of the Missouri College of Agriculture, a file of the American Milk Goat Record Association containing the date of the birth of over 37,000 animals of the several breeds of milk goats was made available for study.

The number of births occurring during the various seasons of the year was determined by grouping the records according to the date of birth of the kids. It is a record of births rather than the number of does which parturated. The months were divided into two parts, 1 to 15 and 16 to 29, 30 or 31 depending on the length of the month. These data show that the does begin to kid in January, about 5 per cent of the total population kidding in the month (Table 1). The number rapidly increases in February and during the first half of March. From that time the number of births gradually declines each month until July when about 3 per cent kidded. From August until December the number of goats kidding is negligible. From January to June over 93 per cent of the goats recorded were born. These data clearly indicate that the milk goats raised in the United States are distinctly seasonal breeders. Included in the group are goats of four breeds, the Toggenburg, the Saanen, the Nubian, and the Alpine. It was at first thought desirable to determine whether there might be a breed variation in regard to this characteristic, but due to the fact that such a small number of goats of the entire population kidded during the latter half of the year, it did not appear possible that such breed variation could exist.

As the duration of pregnancy is 150 to 151 days (Asdell, 2) the date of ovulation and conception can be computed with reasonable accuracy. Thus kids born in January result from estrus cycles occurring in August. From the above data it would appear that following the summer anestrus, the ovaries of a few does begin to function in August. Larger numbers come into estrum in September for the first time and by October estrus cycles are definitely established. These data are believed to indicate that

TABLE 1
Seasons variation in the frequency of births of milk goats

MONTH	NUMBER OF BIRTHS	PERCENTAGE OF TOTAL POPULATION	MONTH OF CONCEPTION (CALCULATED)
Jan. 1-15	625	1.68	August
Jan. 16-31	1260	3.40	
Feb. 1-15	2740	7.39	September
Feb. 16-29	4574	12.27	
March 1-15	6231	16.81	October
March 16-31	5077	13.62	
April 1-15	4326	11.67	November
April 16-30	3129	8.44	
May 1-15	2830	7.63	December
May 16-31	2165	5.84	
June 1-15	1168	3.15	January
June 16-30	761	2.05	
July 1-15	675	1.82	February
July 16-31	449	1.21	
Aug. 1-15	263	0.71	March
Aug. 16-30	169	0.46	
Sept. 1-15	77	0.21	April
Sept. 16-30	67	0.18	
Oct. 1-15	37	0.10	May
Oct. 16-30	31	0.08	
Nov. 1-15	37	0.10	June
Nov. 16-30	63	0.17	
Dec. 1-15	113	0.31	July
Dec. 16-31	207	0.56	
	37,047		

estrus cycles continue in non-pregnant does until late in February or March. Only under exceptional conditions will goats breed from April until July. Ovaries examined at this time show no large follicles or recent corpora.

Recent observations in other forms indicate that the anestrus condition is due to the lack of secretion of two hormones of the anterior pituitary which normally govern the function of the ovary. The injection of these hormones in the proper amounts should cause the ovaries to develop follicles and ripe eggs and thus permit conception to occur during the anestrus period. This would be a great stimulus to the goat milk industry as it would make it possible to have does kid in the fall and thus provide a more uniform supply of milk.

SUMMARY AND CONCLUSIONS

The date of birth of 37,047 kids of the four breeds of milk goats was tabulated to determine the frequency of births at various seasons of the

year. It was observed that about five per cent of the total population kid in January and that the number increases rapidly until the first half of March when over 16 per cent kid (30 per cent for month of March). From that time the number of births declines each month until July, when about 3 per cent kidded. From January to June over 93 per cent of all kids were born.

These data are interpreted as indicating that the milk goats of the United States are seasonal breeders. Considering the period of pregnancy as about 150 to 151 days or roughly five months, the anestrus period of the goat covers at least the months of April, May, June and July. In favorable seasons (cool?) some does will come into estrum in August. From September to February or March regular estrus cycles of about 21 days will occur in normal does with a seasonal anestrus period following.

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A COMPARISON OF THE CHEMICAL COMPOSITION OF PASTURE GRASS WITH A MIXED CONCENTRATE*

EMMETT BENNETT

Massachusetts Agricultural Experiment Station, Amherst, Massachusetts

INTRODUCTION

It has been the purpose of this investigation to ascertain whether or not on a dry matter basis a mixed pasture grass in the vegetative state, fertilized or unfertilized, is comparable from the standpoint of chemical composition with a mixed nitrogenous concentrate such as is fed to dairy cattle in New England.

The investigation has been confined to chemical studies but has gone beyond the scope of the ordinary fodder analysis by resolving some of the major proximate constituents into distinct groups, in order to give more reliable criteria from which to judge the nutritive value of the feeds as revealed by chemical analysis.

Interest has centered principally on the nature of the crude fiber, and the crude protein. The chief aim has been to determine the extent to which lignification has taken place, and in what forms the crude protein exists.

It is generally agreed upon among investigators that the protein content of pasture grass (1, 2, 3, 4) can be increased, and the crude fiber (2, 3, 4) and total dry matter (4, 5) decreased by a system of frequent clippings. The effect of fertilizers in general is to increase the protein (6, 7), and to decrease the crude fiber (6, 8, 9).

If it can be shown that grasses may be substituted for concentrates in the rations of dairy cows it might result, through the development of better and more permanent pastures, in cheaper feed for the New England dairyman.

EXPERIMENTAL PROCEDURE

The materials analyzed included two composite samples of mixed pasture grass, one from pasture which had received heavy annual spring applications of complete fertilizer, and summer applications of nitrogenous fertilizer. The other was from an area adjacent to the fertilized pasture, which had not received any fertilizer treatment. The complete fertilizer was equivalent to 85 pounds of nitrogen (N), 55 pounds of phosphoric acid (P_2O_5), and 67 pounds of potash (K_2O) per acre, while the nitrogenous fertilizer consisted of three separate applications of calurea, each equivalent to 10 pounds of nitrogen (N). The pasture was 50 acres in extent and

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was part of the area included in the regular grazing system on the State College farm. The land was quite level and the soil ranged from a medium loam to a silt loam. The herbage consisted principally of timothy, red top, Kentucky blue grass, and white Dutch clover. Small amounts of orchard grass, sweet vernal grass, Italian rye grass, meadow fescue, and rough-stalked meadow grass were also present.

Representative samples of the herbage were taken throughout the season, which extended from May to October in each of three years (1928-1929-1930). The pasture was kept in a uniformly grazed condition by a system of rotational grazing which is a modification of the so-called Hohenheim system. The samples represented herbage which averaged from four to six inches in height and were collected just before the cattle were turned into the plot. The sampling procedure was as follows: Six points were taken in each plot, three on each of its long dimensions, equidistant from each other, and one-third of the width of the plot from its edge. The points on each plot were not taken opposite each other but were "staggered." At each point a hollow wooden square with an inside area of 4 square feet was dropped on the grass and all herbage inside the square was cut with grass shears as closely as it was considered that cattle would graze, care being taken not to include any soil or grass roots. The grass as soon as cut was taken to the laboratory, air dried in a thin layer, ground, and carefully subsampled for analyses. For comparison a commercial mixed feed such as is commonly fed to dairy cows in New England was analyzed. This concentrate was designed for cows in milk receiving high quality barn-fed roughage and contained hominy, wheat bran, ground oats, cottonseed meal, corn gluten feed, old process linseed oil meal, distillers' grains, molasses, dicalcium phosphate, and salt.

PRESENTATION AND DISCUSSION OF RESULTS

A brief inspection of Table 1 will show the following outstanding facts:

TABLE 1
Fodder analysis

	UNFERTILIZED GRASS	FERTILIZED GRASS	MIXED CON- CENTRATE
	%	%	%
Moisture (as analyzed)	6.49	6.16	9.74
<i>Dry matter</i>			
Crude protein	13.31	18.44	19.44
Crude fiber	24.41	22.99	7.72
Ether extract	2.78	3.03	5.44
N-free extract	51.46	45.94	60.22
Crude ash	8.04	9.60	7.18

(1) The application of fertilizer resulted in producing a grass of considerably higher protein, and decreased fiber content.

(2) The concentrate is characterized by a high protein, and a relatively low fiber content, and has a relatively high concentration of the storage groups. The subsequent tables show the results obtained by the analysis of some of the proximate fractions in Table 1.

(a) *Total Nitrogen*

TABLE 2
Nitrogen partition

	UNFERTILIZED GRASS		FERTILIZED GRASS		MIXED CONCENTRATE	
	Percentage in dry matter	Percentage in total nitrogen	Percentage in dry matter	Percentage in total nitrogen	Percentage in dry matter	Percentage in total nitrogen
Total nitrogen	2.13		2.95		3.11	
Protein nitrogen	1.94	91.08	2.72	92.20	2.93	94.22
Amino nitrogen	0.17	7.98	0.20	6.78	0.15	4.82
Ammoniacal nitrogen	0.02	0.94	0.03	1.02	0.03	0.96
Nitrate nitrogen	0.00	0.00	0.00	0.00	0.00	0.00

The facts presented in this table clearly show that:

(1) Fertilizer treatment increased the total nitrogen to almost the level of that found in the concentrate.

(2) The percentage of amino nitrogen in the total nitrogen is somewhat higher in the unfertilized than in the fertilized grass, and is considerably higher in the grasses than in the concentrate.

(3) The protein nitrogen together with the amino nitrogen constitutes about 99 per cent of the total nitrogen in all cases.

(4) Except for the amino acid fraction the partition ratios show very little difference between the grasses and grain, and practically none between the grasses.

(5) Nitrates were not detected in any case.

(b) *Cellulose and Lignin*

The grasses have considerably more cellulose than the concentrate, although this fraction is not paralleled by a correspondingly high percentage of lignin. Instead, we find the lignin of the grasses to be approximately 30 per cent as great as the cellulose, whereas the lignin in the concentrate is approximately 42 per cent as great as the cellulose present. In

TABLE 3
Cellulose and lignin

	UNFERTILIZED GRASS	FERTILIZED GRASS	MIXED CONCENTRATE
	%	%	%
Cellulose	18.30	16.28	8.17
Lignin	5.18	5.17	3.42

NOTE.—In Table 3 cellulose and lignin are considered instead of crude fiber, since they form the largest part of this proximate constituent.

absolute percentage the lignin in the grass exceeds that in the concentrate by approximately 1.75 per cent.

(c) *Nitrogen-Free Extract*TABLE 4
Nitrogen free extract

	UNFERTILIZED GRASS	FERTILIZED GRASS	MIXED CONCENTRATE
	%	%	%
Reducing sugar	2.14	2.46	1.47
Sucrose	4.87	7.53	10.19
Starch	5.07	4.87	34.54
Pentosans	16.02	15.91	12.86
Hemicelluloses	20.06	17.68	6.51

The chief effect of fertilizer treatment in this fraction lies in an increased percentage of sucrose, and a decrease in percentage of hemicelluloses.

The most significant class difference is the high percentage of starch, and the low percentage of hemicelluloses in the mixed concentrate.

(d) *Ash*TABLE 5
Ash

	UNFERTILIZED GRASS	FERTILIZED GRASS	MIXED CONCENTRATE
	%	%	%
Total ash	8.03	9.59	7.11
Insoluble ash	2.85	3.17	0.51
Soluble ash	5.18	6.42	6.60
Calcium	0.52	0.52	0.49
Magnesium	0.31	0.30	0.37
Phosphorus	0.29	0.31	0.98
Sulphur	0.58	0.56	0.53
Iron	0.07	0.12	0.06

Both soluble and insoluble ash were increased in the fertilized grass. The concentrate, while yielding the lowest total ash, furnished the greatest amount of soluble ash. The phosphorus was much higher in the concentrate.

A graphic presentation of the more significant foregoing results is portrayed in figures 1 and 2.

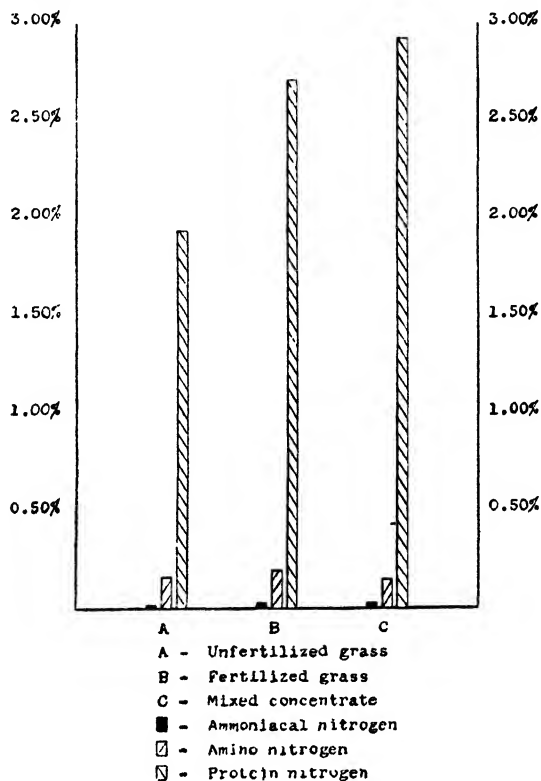


Fig. 1

FIGURE 1. A distribution graph showing the nitrogen partition of the total nitrogen fraction of the feeds.

SUMMARY AND CONCLUSIONS

The following are the outstanding facts shown by this investigation:

- (1) Pasture grasses contain a highly elaborated type of nitrogen irrespective of fertilizer treatment.
- (2) The application of fertilizer had the following effects:
 - (a) An increase in the percentage of crude protein.
 - (b) A decrease in the percentage of crude fiber.

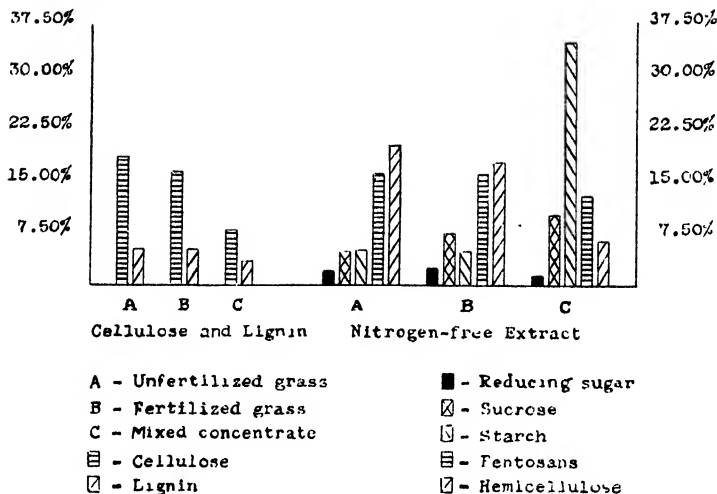


FIGURE 2. A graph showing the association of cellulose and lignin, and the various components of the nitrogen-free extract fractions of the feeds.

(c) A decrease in the percentage of nitrogen-free extract. An increase in sucrose was compensated by a decrease in hemicelluloses.

(d) An increase in the total ash.

(3) The percentage of crude fiber in the grasses was practically three times that in the concentrate, the difference being due principally to a larger amount of cellulose in the grasses. The lignin content of the grasses was approximately 30 per cent as great as the cellulose, while in the concentrate it was approximately 42 per cent as great.

(4) The grasses contained approximately 1.75 per cent more lignin than the concentrate.

(5) The concentrate was characterized by a relatively high percentage of sugar and starch.

These results supplementing other information in the literature would seem to justify the conclusion that for the dairy cow the dry matter of pasture grass in the vegetative state is comparable with concentrated feeds, and that its chemical composition can be so changed by the application of fertilizer that its character closely approaches that of a nitrogenous concentrate.

ACKNOWLEDGMENTS

The writer wishes to express his indebtedness to Professor J. G. Archibald, under whose direction this investigation was carried on, for his valuable criticisms and helpful suggestions; and to Dr. J. B. Lindsey, whose cooperation made possible this investigation.

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THE PHOSPHOLIPIDS IN MILK

IV. THEIR CHEMICAL NATURE AND THEIR DISTRIBUTION AMONG SOME MILK PRODUCTS

GEO. E. HOLM, P. A. WRIGHT, AND E. F. DEYSHER

*Division of Dairy Research Laboratories, Bureau of Dairy Industry,
U. S. Department of Agriculture*

The phospholipid content of milk and various dairy products has been determined by a number of investigators (1). The great variations in the values recorded can no doubt be accounted for on the basis of different methods used in the isolation of the lipid material.

The present authors in their former study of milk (1) used the method of Bloor, as modified by Meigs (2) and used by him in the study of blood lipids, for the separation of this material. This method consists of an extraction with a mixture of 3 parts of 95% ethanol and 1 part of ether. Though the method seems to give excellent results when used in blood studies, it does not seem adaptable to milk or milk products without some modification because of the slight solubility of phosphates in the extraction mixture. Hence in the work on milk referred to, the values given for the percentage phospholipid content of milk as well as of its products were too great, except for those cases wherein the determinations were carried out on the pure lipid material isolated in the various fat tests studied.

This was revealed by our subsequent work, the results of which led to the conclusion (3) "that the values for the phospholipid content of milk of the order of those obtained by Mohr, Brockmann and Müller represent the phospholipid content of milk most accurately."

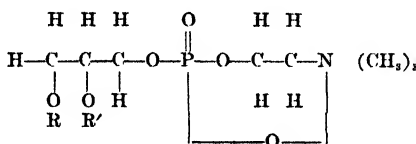
Wiese, Nair and Fleming (4) and Perlman have used the Mojonnier modification of the Roese-Gottlieb method for the extraction of lipid material from cream. The former report 18-20 mgs. of phosphorus in 100 grams of extract while the latter reports values of 14.5 and 15 mgs. in similar extracts from creams of approximately 40% fat content. Horrall (6) using a similar extraction method has determined the phospholipid content of milk and some of its products. The values obtained are generally in agreement in their order of magnitude with those of Mohr, Brockmann and Müller (13).

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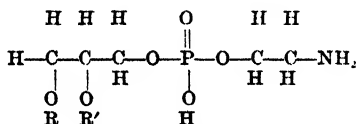
CHEMICAL NATURE OF PHOSPHOLIPID MATERIAL IN MILK

The percentage of phospholipids is usually calculated from the phosphorus content of the material analyzed. Though it has been shown by Osborne and Wakeman (8), Osborne (9) and Koch and Woods (7) that the phospholipids of milk are composed of a mixture of phospholipids the factor used for the conversion is usually calculated upon the assumption that the material is a distearyl or an oleo-stearyl lecithin.

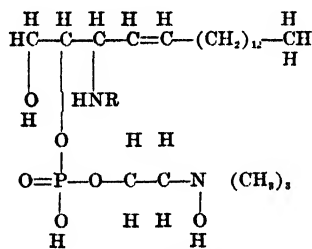
In a study of the material isolated from fresh dry buttermilk Kurtz, Jamieson and Holm (10) found that it was composed of lecithin, cephalin, sphingomyelin present in the ratio of 8.4:4.5:1, respectively. The general structural formulas of these compounds are as follows.



Lecithins



Cephalins



Sphingomyelins

Cerebrosides were also found present but since these contain no phosphorus they are of no concern here.

The material was further purified and then separated into a fraction containing lecithin and cephalin and one composed of sphingomyelin and cerebrosides. These have been analyzed for their fatty acid constituents in order to determine as accurately as possible the phosphorus ratio in the composite material.

Analysis of the lecithin-cephalin fraction indicated that its constituency of fatty acids was of the following nature and proportion (10).

Myristic	5.2%
Stearic	16.1
Archieidic	1.8
Oleic	70.6
Dicostetrenoic (?)	6.3

The acids of the cephalin-sphingomyelin fraction are composed almost entirely of lignoceric acid. From analyses it was calculated that 60.43% of the total isolated material was lecithin, 32.37% was cephalin and 7.20% was sphingomyelin. The average molecular weight of the lecithin-cepahlin fraction was calculated to be 773.6, on the basis of 8.4 parts of lecithin to each 4.5 parts of cephalin.

On the basis of unpublished data on the analysis of the acid content of the sphingomyelin-cerebroside fraction the molecular weight of the sphingomyelin was calculated as 805. The distribution of lecithin-cepahlin to sphingomyelin was 12.9 to 1.0. On this basis the average molecular weight of the phospholipid material would be 775.76, or slightly higher than would be the case if the phospholipid were a lecithin of the oleo-stearyl or distearyl type. Phosphorus represents 4% of this weight and the factor for conversion of phosphorus to milk phospholipids would therefore be 25.00. This factor has therefore been used tentatively in conversion of the organic phosphorus in the various samples into percentage of phospholipids.

EXPERIMENTAL

Extraction of lipid material: The isolation of phospholipid material from milk or its products has been accomplished by various solvents. The method of Bloor utilizes a mixture of ether and ethanol. Broderick-Pittard's method employs an ether-ethanol mixture for the first extraction with a subsequent extraction with chloroform, after desiccation. Wiese, Nair and Fleming, and Horrall extracted the lipid material by the Mojonnier and Troy modification of the Roese-Gottlieb method.

The choice of solvent to be used in this work was determined through a consideration of the properties of the material isolated by Kurtz, Jameson and Holm (10). This material was purified and separated into an ether-soluble and ether-insoluble fraction as described. One consisted of lecithin and cephalin while the other was evidently a mixture of sphingomyelin and cerebrosides.

The approximate solubilities of these two have been determined as given in Table 1.

In view of these results the most thorough extraction of phospholipid material should be accomplished with a combination of solvents; perhaps in the manner in which they were employed by Broderick-Pittard (11).

The results indicate also that cold ethanol-ether or cold ethanol-

TABLE 1
Solubilities of phospholipid fractions in various organic solvents

	ETHER	PET. ETHER	ETHANOL (95 %)	CHCl ₃
Lecithin-cephalin	v. sol.	v. sol.	Somewhat sol. (room temp.)	v. sol.
Sphingomyelin-cerebroside	prac. insol.	insol.	1.90 (room temp.) 13.0 (hot)	20.0 (room temp.) v. sol. (hot)

petroleum ether mixtures are not extremely efficient solvents for the sphingomyelin-cerebroside fraction.

In view of these data the extractions were carried out, as follows:

Whole milk, skim milk, buttermilk, cream: 100 cc. of product were run dropwise from a graduated pipette into a constantly agitated (by rotation) mixture of 375 cc. absolute ethanol and 125 cc. USP ether at room temperature. The contents of the receiving flask were heated to active boiling on the steam bath and filtered, the filtrate being secured in a 16 oz. glass mortar. The precipitate was removed from the flask with small portions of ethanol, ether and chloroform. After thorough drainage the precipitate was removed from the filter paper with a spatula and mixed thoroughly with Na₂SO₄ (anhydrous) and a small amount of white sea sand.

The mortar containing the filtrate and washings was placed in a desiccator, without the porcelain plate, and the water-ether-ethanol-chloroform mixture evaporated by impinging up the surface of the liquid a gentle stream of air, filtered through absorbent cotton and heated by passing through a metal receptacle placed upon a hot plate, with the current switch turned to the "high" position. Usually two seven-hour periods were necessary to complete the evaporation, as the last traces of water evaporated with difficulty. With the exception of the cream which required special treatment before the chloroform extraction, the dry precipitate-sand-Na₂SO₄-mixture, was transferred to this latter mortar containing the dry residue—more or less softened with fat—and the whole thoroughly blended to produce a uniform mixture. This final mixture was transferred by spatula to a paper Soxhlet thimble, covered with washed fiber asbestos wool, and a metal screen, and placed in the extraction tube of a large sized pyrex Soxhlet extractor. The chloroform necessary to operate the extraction was used in 6 or 7 portions to wash and rinse thoroughly the mortar, pestle, stirring rods, spatulas, and camels' hair brush used in mixing and transferring the mass to be extracted. These portions of chloroform were filtered successively through a small folded filter. The extraction with C. P. chloroform was continued for 72 hours. Usually after the first 24 hours a flask containing fresh solvent was introduced in place of the flask of solvent containing the extraction of the first 24 hours.

Cream: After evaporation of the solvents in the stream of filtered and heated air, and incorporation of the precipitate with the sand- Na_2SO_4 mixture, and before transferring to the extraction thimble, the mixture was flooded successively two or three times with U. P. chloroform. After thorough mixing with chloroform and subsequent settling, the chloroform was drained off by gentle suction each time into a flask and filtered through a small folded filter into an extraction flask and held until the 72-hour extraction was finished when it was incorporated with the remainder of the extraction solvents. From here on the cream residue-sand- Na_2SO_4 was treated exactly as has been described for the whole milk-skimmilk-butter-milk procedure.

Butter: Thirty grams of butter, weighed out as described, was mixed with the sand and anhydrous Na_2SO_4 (about one part butter to two parts Na_2SO_4), the mixture heated until the butter was melted, and the mixture flooded with chloroform and extracted as described for cream.

After the 72-hour extraction was completed, the exhausted thimble was removed from the extraction tube, which was used to receive the excess solvent, distilled off from the one to three extraction flasks containing different portions of the extract. The various portions of extract were combined and after the extract was reduced to the lowest safe volume it was transferred to an 800 cc. Kjeldahl flask and the extraction flask rinsed with chloroform. The Kjeldahl flask was partly immersed in hot water in a large beaker on an electric hot plate and the remaining solvent evaporated by a gentle current of filtered air.

Digestion: The digestion of the material from each extraction was accomplished with concentrated H_2SO_4 and HNO_3 and the volume of excess H_2SO_4 reduced with formaldehyde. A suitable amount of concentrated H_2SO_4 , depending upon the amount of fat in the product, was added to the contents of the flask. From three to six glass beads were added to prevent bumping. The amount of H_2SO_4 was usually 25 cc. in case of whole milk, skim milk, and buttermilk, 80 cc. in the case of cream, and 60 cc. in the case of butter. The concentrated HNO_3 was added in very small portions or drop by drop from a separatory funnel, the rate depending upon the reaction. The larger the amount of fat to be digested, the more caution was necessary. No heat was applied to the flask until frothing had practically ceased. Then heat was applied slowly with a micro burner, and was gradually increased until the full flame of a regular Bunsen burner was used. After frothing had ceased, the HNO_3 was added at the rate of about 2 drops per second. Heat and speed of adding were carefully regulated to obtain a balance between overdue charring and excessive dilution.

Usually about 50 cc. of HNO_3 was necessary with whole milk, etc., and approximately 200 cc. with cream and butter. After the liquid in the flask

had become transparent, the addition of HNO_3 was discontinued, the nitric oxide fumes boiled off, and the addition of formaldehyde solution begun. Here again caution was necessary to add the solution fast enough so as not to take an excessive time to reduce the volume of H_2SO_4 , and not so fast as to produce excessive charring on the side of the flask. The method is very satisfactory and rapid if a proper balance is maintained between temperature of heating and speed of dropping in formaldehyde solution.

The volume of H_2SO_4 was reduced to not more than 10 cc. When this had been accomplished the char in the flask was oxidized with concentrated HNO_3 added drop-wise while heating.

Phosphorus Determination: After the digestion was completed the H_2SO_4 content was approximately 10 cc. The contents were washed into a flask and made up to volume of 110 cc. For the determination of phosphorus the method of Woy (12) was chosen, because of the fact that phosphorus represents but 1.72% of the weight of the yellow precipitate after ignition to $\text{P}_2\text{O}_5 \cdot 24\text{MoO}_3$. The procedure was as follows: 50 cc. of the digested solutions were measured in duplicate into 400 cc. beakers, neutralized with NH_4OH , 25 cc. of 50% NH_4NO_3 and 20 cc. of 25% HNO_3 added, then heated until bubbling occurred and the required hot 3% ammonium molybdate run in from a separatory funnel in a thin stream, with continual shaking. In 10 to 15, min. the solution was clear and the yellow precipitate was ready to filter. After washing the precipitate with 5% ammonium nitrate 2 or 3 times, by decantation, the precipitate was dissolved in NH_4OH , reprecipitated by the addition of the necessary amount of ammonium nitrate, ammonium molybdate and HNO_3 . The yellow precipitate is then filtered into a Gooch crucible, washed with 5% ammonium nitrate, ignited in the muffle at a temperature of 400–450° C. and weighed as $\text{P}_2\text{O}_5 \cdot 24\text{MoO}_3$. The phosphorus represents 1.72% of the weight of the precipitate.

RESULTS

Whole milk of 3.88 per cent fat content was separated and the resulting cream was churned and samples of each product collected for analyses. The separator slime was not collected separately but was washed into the skim milk fraction.

Each sample was extracted as described and the phosphorus content of the extraet determined. This was multiplied by 25.00 to convert the phosphorus into phospholipids. Following are the results of the analyses.

The results are in agreement with those of Mohr, Brockmann, and Müller. The seeming lack of agreement in the values for cream, butter, and butter-milk, may be accounted for by the differences in distribution of amount of product due to the use of cream of 23 per cent fat content, whereas the fat content of that used in this work was 41 per cent.

TABLE 2
Amount and distribution of phospholipids of milk

PRODUCT	AMT. USED	FAT IN PRODUCT	PHOSPHO-LIPIDS IN FAT	PHOSPHO-LIPIDS IN PRODUCT	PHOSPHOLIPIDS IN PRODUCT	PERCENTAGE OF TOTAL PHOSPHOLIPIDS IN MILK	PERCENTAGE OF PHOSPHOLIPIDS IN CREAM
		gm.	per cent	per cent	gm.	per cent	per cent
Whole milk (3.88)*	152,628	5,931.97	.0869	.0337	51.44	100.00	
Skim milk	137,818	124.04	17.29	.0169	23.29	45.28	
Cream (41.13)*	14,815	6,093.41	0.442	1816	26.90	52.30	
				Total	50.19		
Cream					26.90		
Buttermilk	8,017	155.53	9.378	.1819	14.58	28.34	54.20
Butter	6,798	5,765.38	0.2207	.1872	12.72	24.73	47.39
				Total	27.30		

* Per cent fat content of product.

TABLE 3

Phospholipid content of milk and milk products according to Mohr, Brockmann and Muller, Horrall, and the authors

	MOHR, BROCKMANN AND MULLER (13)	HORRALL (6)	AUTHORS
	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>
Whole milk	.037	.0276	.0337
Skim milk	.0155	.0166	.0169
Cream	.1685 (23%)*	.155 (37.67%)*	.1816 (41%)*
Butter	.2060	.1685	.1819
Buttermilk	.1142	.1415	.1872
Separator slime		.68	

* Per cent fat content of cream.

As stated heretofore the results previously published upon the phospholipid distribution in milk products were in error. This does not apply, however, to the results obtained in experiments wherein the fat was used in the analyses (articles II and III of the series). In these experiments it was shown that the amount of phospholipids in the fat extracted from representative samples of buttermilk by the Roesse-Gottlieb method was 13.18 per cent (av.), and in that from skim milk was 16.36 per cent (av.), the actual value in any case being dependent upon the fat content of the product. Horrall obtained values of 13.91 and 19.66 per cent upon representative samples of skim milk and buttermilk, respectively.

CONCLUSION

The chemical nature of the phospholipids of milk has been discussed, their approximate solubilities given, and a tentative composite molecular weight established. In view of the solubilities given it is doubtful if extraction of phospholipids can be completed without the use of hot ethanol or the supplementary use of extraction with chloroform.

The molecular constitution of the phospholipids has been discussed and the molecular weight calculated as 775.76 on the basis of analyses of the phospholipid fractions. On this basis the factor for the conversion of phosphorus into milk phospholipids would be 25.00.

The distribution of the phospholipids among some of the products has been determined.

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INFECTIOUS BOVINE MASTITIS

REPORT ON A CONTROL PROGRAM BASED ON SEGREGATION OF INFECTED ANIMALS*

W. N. PLASTRIDGE, E. O. ANDERSON, F. J. WEIRETHER AND R. E. JOHNSON
Storrs Agricultural Experiment Station, Storrs, Connecticut

In a previous publication (1), a program for the control of infectious bovine mastitis was described and the results of preliminary observations presented. The plan involved systematic periodic examinations of the milk and segregation of affected animals. The segregation plan was started in one herd in 1930 and continued for a period of two years. Since 1932 data have been collected on six other herds. All animals were free from Bang's abortion disease and tuberculosis. It is the purpose of this paper to present briefly the results obtained up to the present time.

METHODS**

Individual quarter samples were collected aseptically from all milking animals in the six experimental herds at intervals of three months. The following determinations were made on each sample: Physical appearance, reaction to bromthymol blue, leucocyte count, microscopic examination of films prepared from incubated portions of the samples, and isolation and identification of streptococci, when present. A leucocyte count of 500,000 or more and the presence of *Streptococcus mastitidis* (Group A)*** were considered positive evidence of infectious mastitis. On the basis of the tests employed, the milking animals in six of the seven herds under observation were divided into one of the following groups:

Group I. Animals classed as negative.

Group II. Animals showing suspicious or positive evidence of mastitis due to causes other than streptococci (chiefly hemolytic staphylococci). Evidence of mastitis associated with staphylococci was usually transitory and was limited, with few exceptions, to an abnormally high leucocyte count.

Group III. Animals showing suspicious or positive evidence of mastitis due to streptococci other than *Streptococcus mastitidis* (Group A); usually

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* The control program was described before the 1934 (December) meeting of the North American Conference of Official Research Workers in Animal Diseases. The results reported herein were presented at the 1935 (December) meeting.

** For a description of methods employed, readers are referred to Bulletins 195 and 197 of the Storrs Agricultural Experiment Station, Storrs, Connecticut.

*** Identical with "Mastitis streptococcus Group 1" of Minett (2), and is apparently identical with *Streptococcus agalactiae* (Kitt, 1893).

Group B streptococci, which is apparently identical with "Mastitis streptococcus (Group III)" of Minett (2).

Group IV. Animals shedding *Streptococcus mastitidis* (Group A) without showing other evidence of mastitis.

Group V. Animals eliminating *Streptococcus mastitidis* (Group A) and showing other positive evidence of mastitis.

The animals were arranged in the barn and milked in the order suggested by the group classification.

RESULTS

The results obtained to date on seven experimental herds in which mastitis has been observed for periods of from one to six years are given here, briefly.

Herd F. Preliminary observations on the influence of segregating animals showing evidence of chronic streptococcal mastitis were made on Herd F, and were referred to in 1934 in Storrs Experiment Station Bulletin 197. A summarization of the data collected over a period of four years (1928 to 1932) is given in Table 1.

TABLE 1
Incidence of Streptococcal mastitis in Herd F.*

ANIMALS	BEFORE SEGREGATION		AFTER SEGREGATION	
	1928 to 1929	1929 to 1930	1930 to 1931	1931 to 1932
Total number	27	34	30	26
Had mastitis previously	3	7	4	1
Changed from negative to positive	6	3	1	0
Change from positive to negative	0	1	0	0
Positive animals removed	2	5	4	0
Negative animals removed	2	9	9	0
1st calf heifers	9	11	10	9
Total incidence, per cent	33.3	29.4	16.6	3.8
Incidence of new infection, per cent	22.2	8.8	3.3	0.0

**Streptococcus mastitidis* (Group A).

During the first 18 months no attempt was made to segregate animals affected with mastitis, with the result that during the first year the total incidence of infection with *Streptococcus mastitidis* (Group A) was 33.3 per cent and the incidence of new infection 22.2 per cent. Late in the second year the infected animals were placed at one end of the barn and milked last; five infected animals and nine streptococcus-free animals were sold and eleven first calf heifers added. During the second year the total incidence of affected animals was 29.4 per cent and the incidence of new infection decreased to 8.8 per cent.

The policy of segregation and gradual replacement of infected animals with first calf heifers was followed during the next two years. As a result the total incidence of infection was reduced from 29.4 per cent to 3.8 per cent. The incidence of new infection during the third year, or first year following segregation, was 3.3 per cent and was nil the following year. Further data were not secured, as the entire herd was disposed of in the summer of 1932.

Herd C. The average yearly incidence of streptococcal mastitis in Herd C for a period of four years preceding segregation is available for comparison with the incidence of the disease following adoption of the segregation program. Herd C differed from the others by being divided into four general sections according to breed. The results obtained in Herd C before and after segregation of affected animals are summarized in Table 2.

TABLE 2
Incidence of Streptococcal mastitis in herd C*

ANIMALS	BEFORE SEGREGATION	AFTER SEGREGATION	
	Yearly average for 4 year period preced- ing segregation	1 year 2/19/34- 2/6/35	8 months 2/5/35- 10/23/35
Total number	55	57	52
Had mastitis previously	14	11	6
Changed from negative to positive	7	2	1
Changed from positive to negative	0	2	1
Positive animals removed	7	3	1
Negative animals removed	7	12	8
1st calf heifers	18	16	10
Total incidence, per cent	38.2	22.8	13.5
Incidence of new infection, per cent	12.7	3.5	1.9

**Streptococcus mastitidis* (Group A).

During the four years preceding segregation the average yearly incidence of streptococcal mastitis was 38.2 per cent, and the average yearly incidence of new infection 12.7 per cent. During the first year of segregation the incidence of new infection decreased from the preceding yearly average of 12.7 per cent to 3.5 per cent, and the total incidence of infection decreased from the average of 38.2 per cent to 22.8 per cent. During the following eight months only one additional animal yielded laboratory evidence of streptococcal mastitis, and the total incidence of mastitis decreased to 13.5 per cent.

The reduction in total incidence of streptococcal mastitis from the average of 38.2 per cent before segregation to 13.5 per cent 20 months following adoption of the segregation program is attributed to three factors: (1) a marked reduction in the rate of spread as the result of segregating

infected animals, (2) apparent recovery of three animals, and (3) replacement of three positive animals by first calf heifers.

Herd G. The results obtained on Herd G are of particular interest because mastitis was a serious problem in this herd from the time the experimental use of bacterins was started in 1928 until after a program of segregation was started in the fall of 1933. The results of periodic examinations made during the two years preceding segregation have been summarized in Table 3 for comparison with the results obtained following segregation.

TABLE 3
Incidence of Streptococcal mastitis in herd G*

ANIMALS	BEFORE SEGREGATION		AFTER SEGREGATION	
	1931-32	1932-33	1933-34	1934-35
Total number	41	40	50	48
Had mastitis previously	12	4	7	0
Changed from negative to positive	4	5	0	1†
Changed from positive to negative	0	0	0	1†
Positive animals removed	12	2	7	1†
Negative animals removed	3	2	7	4
1st calf heifers	5	14	14	12
Total incidence, per cent	39.0	22.5	14.0	2.1
Incidence of new infection, per cent	9.8	12.5	0.0	2.1

**Streptococcus mastitidis* (Group A).

† This animal occupied quarters formerly used by positive group, yielded Group A streptococci on last test of lactation period, was negative on first test following calving and was sold shortly after calving.

During the year 1931-32 the total incidence of streptococcal mastitis in this herd was 39.0 per cent, and the incidence of new infection 9.8 per cent. Twelve animals that had been affected with chronic mastitis for several years were disposed of for economic reasons. However, four infected animals were left in the herd. The following year (1932-33) five instances of new infection accounted for a 12.5 per cent increase in infection. These five animals, together with the four previously infected ones, made a total incidence of 22.5 per cent. Two of the nine positive animals were sold.

The segregation program was begun in the fall of 1933 with seven positive animals in the herd at the start. These were placed at one end of the barn and milked last. Since no new infection occurred during the first year of segregation (1933-34), and as two positive animals were sold and 14 heifers added, the total incidence of mastitis decreased to 14.0 per cent. Since the program seemed to be progressing satisfactorily and a number of first calf

heifers were available for replacements, the owner disposed of the remaining seven positive animals.

At the beginning of the second year of the segregation program none of the animals showed evidence of infection with *Streptococcus mastitidis* (Group A). However, after the herd was rearranged, following disposal of the seven positive cows, negative animals were moved into the quarters formerly occupied by the positive group. One of these animals became infected with Group A streptococci and showed slight evidence of mastitis on a single test, but returned to negative on the following test. She was sold shortly thereafter. This animal accounts for the one instance of new infection and the single instance of recovery noted in the last column of Table 3. The total incidence of infection for the year 1934-35 was 2.1 per cent.

It is interesting to note that four of the five cases of new infection observed during the year 1932-33 were animals located next to or second from a positive animal.

Three instances of infection with Group B streptococci occurred in Herd G during the two year period from 1933 to 1935. One infected quarter gave abnormal milk for a period of several weeks immediately following calving. Thereafter the secretion from this quarter was normal in appearance and failed to yield either laboratory evidence of mastitis or Group B streptococci on subsequent tests. Evidence of mastitis in the other two animals infected with Group B streptococci was limited to an abnormally high leucocyte count. One of these yielded Group B streptococci on one test only; the other shed Group B streptococci for a period of about 15 months. The secretion from this animal was normal in appearance and repeatedly gave a normal reaction to the bromthymol blue test.

Herd Ch. Periodic examinations were made on Herd Ch for a period of 15 months. In as much as the segregation program was not carried out as recommended, the results obtained on this herd are of value principally for comparison with the results obtained on herds in which segregation was practiced. While the animals placed in Group 5 were later removed to a position near the end of the milking string, this was not done consistently and several months usually elapsed between the time the animals were classified and the time Group 5 animals were moved to the end of the line. The results obtained on Herd Ch are summarized in the first column of Table 4.

Six animals were classified as positive in the first test. During the 15 months' period of observation five additional animals became infected, with the result that the total incidence of mastitis was 24.4 per cent and the incidence of new infection 11.1 per cent. Four of the five instances of new infection were apparently traceable to two positive animals which were located near the head of the milking string and which were not removed as

TABLE 4
Incidence of *Streptococcal** mastitis in four other experimental herds

ANIMALS	NOT SEGREGATED	SEGREGATED	SEGREGATED	NEGATIVE HFRD
	Herd Ch (15 months)	Herd Gr (12 months)	Herd H, (12 months)	Herd O F (3 years)
Total number	45	59	61	11
Had mastitis on first test	6	13	9	0
Changed from <i>negative</i> to <i>positive</i>	5 ^a	4 ^b	3 ^c	0
Changed from <i>positive</i> to <i>negative</i>	1	0	0	0
Positive animals removed	4	5	7	0
Negative animals removed	5	9	6	1
1st calf heifers added	13	25	17	3
Total incidence, per cent	24.4	28.8	19.7	0.0
Incidence of new infection, per cent	11.1	6.8	4.9	0.0

**Streptococcus mastitidis* (Group A).

^a Four of the five instances of new infection were animals located next to previously affected animals which had not been segregated

^b All four instances of new infection were animals located next to the positive group (Group 5)

^c In two instances infection followed injury to a teat. The third animal was located next to the positive group (Group 5)

recommended at the time of the preceding test. The fifth animal was located next to a positive cow near the end of the milking string.

Herd Gr. The segregation program was started in Herd Gr in July, 1934. Animals were arranged in the barn and milked in the order suggested by the grouping. The results obtained on Herd Gr are summarized in the second column of Table 4.

Thirteen animals were placed in Group 5 at the time of the first test. During the year four animals became infected. The position of the newly infected animals in this herd is of particular interest. On the second test, one new positive was found. This animal was located next to the first animal in Group 5. On the third test two new positives were found. One of these was located next to the first animal in Group 5, and the second next to the other newly infected animal. The single newly infected animal, identified as such in the fourth test, was also located next to Group 5. The incidence of new infection for the twelve months' period of observation was 6.8 per cent, or at least half of what might be expected if the positive animals had not been segregated.

The results obtained with Herd Gr suggest three important factors that must be considered in the control of infectious streptococcal mastitis: (1) that grouping the positive animals at one end of the barn and milking them

in the order suggested by this grouping greatly reduces, but does not entirely prevent spread of infection, (2) that apparently infection may be transmitted to negative animals by contact with floors that have been infected by carrier animals, and (3) that isolation of the positive animals, rather than placing them at the end of the milking string, is necessary to prevent completely the spread of infectious streptococcal mastitis.

Herd H. The milking animals in Herd H were examined for the first time in November, 1934. The segregation program was started as indicated by the results of the first test. The data secured are summarized in the third column of Table 4.

At the outset nine animals were placed in Group 5. During the year three additional animals became infected with *Streptococcus mastitidis* (Group A). In two instances infection was preceded by injury to the teat of the affected quarter. The location and order of milking of these animals following injury is not known. The third animal that became infected was located next to the first animal in Group 5. During the year the total incidence of mastitis due to Group A streptococci was 19.7 per cent, and the incidence of new infection was 4.9 per cent.

Herd O. F. The results obtained with Herd O. F. are summarized in the fourth column of Table 4. This herd is of particular interest, as it was started in 1932 from eight pregnant heifers purchased from a herd which was accredited free from Bang's abortion disease and tuberculosis. Samples were collected from all milking animals and examined at intervals of one month. Several of the cows are now in their third lactation. During the three year period of observation over 500 quarter samples were examined without finding a single instance of infection with either *Streptococcus mastitidis* (Group A) or with Group B streptococci. Saprophytic streptococci which were readily differentiated from *Streptococcus mastitidis* (Group A) and Group B streptococci, were obtained from 15 samples. None of these samples contained an abnormal number of leucocytes or showed other evidence of mastitis.

DISCUSSION

While numerous species of bacteria have been found to be associated with bovine mastitis, streptococci have been reported most frequently as the common cause of the disease. It is also evident from the literature on this subject that more than one species of streptococci may cause mastitis. However, the work of Jones (3) in 1918 indicated that the majority of streptococci associated with mastitis possessed similar characteristics. More recently numerous reports have shown that the common cause of infectious bovine mastitis is a fairly well defined species of *Streptococcus* (4, 5, 6, 7, 8, 9, 10 and 11). The recognition of a specific organism as the common causative agent in infectious bovine mastitis offers a definite basis for a

program of control based on prevention by segregation of animals harboring this organism.

The advisability of segregating animals affected with mastitis has been recognized since the early work of Franck (12) in 1875 and Nocard and Mollereau (13) in 1887. A decrease in incidence of mastitis in four herds over a two year period following a program of isolating cows affected with mastitis and careful attention to dairy hygiene, was observed by Hardenberg and Schlotthauer (14). Udall and Johnson (15) in 1930 and 1931 advised placing all affected animals, as determined by physical examination of the udder and reaction of the udder secretion to the bromthymol blue test, in a single group, to prevent spread of infection to mastitis-free animals. More recently isolation of animals based on the results of cultural tests for the detection of streptococci in the udder secretion has been recommended by Seelemann (16), Steck, Bachmann, Kaestli and Gygax (17), Hueker (18), Minett, Stableforth and Edwards (19), and Plastridge, Anderson, Brigham and Spaulding (7).

Evidence that herds free from *Streptococcus agalactiae*, referred to in our reports as *Streptococcus mastitidis* (Group A) may be established by a program of segregation and gradual replacement of infected animals with first calf heifers was presented by Minett, Stableforth and Edwards (19) in 1933, and by Plastridge, Anderson, White and Rettger (1) in 1934. Recently Stableforth, Edwards and Minett (20) have described the results of further observations on six herds in which contagious streptococcal mastitis was reduced and in some instances eliminated by segregation and disposal of infected animals.

Results obtained in six herds by use of the segregation program described by us (1) in 1934 are presented here. Observations made on these herds showed that the annual rate of spread was reduced from 50 to 100 per cent by use of the plan. In one herd (Herd G) infection with *Streptococcus mastitidis* (Group A) was completely eliminated by gradual replacement of infected animals with first calf heifers.

With few exceptions, the limited number of instances of new infection occurred in animals located in the barn next to the group infected with streptococci (Group 5). As the negative animals were milked first, it appears that in these instances infection spread to the negative animals by contact with the floor or litter contaminated by the infected animals.

The results obtained on a herd recruited from pregnant heifers (Herd O. F.) are of particular interest, as tests made at monthly intervals since the herd was started in 1932 show that the animals have remained free from *Streptococcus mastitidis* (Group A) up to and including the time of the last test which was made January 20, 1936. This finding is in accord with that reported by Seelemann (16), who observed that several self-contained herds were entirely free of the "galt" streptococcus, and that the herds remained so unless infected animals were introduced.

SUMMARY

Observations on the incidence of streptococcal mastitis in seven experimental herds over periods of from one to six years are described. Data collected before and after the adoption of a program of segregation based on periodic examinations (chiefly bacteriological) and segregation of animals shedding streptococci identified as *Streptococcus mastitidis* (Group A)*, are presented. The results obtained indicate that:

1. The annual rate of spread of infectious streptococcal mastitis in infected herds may be reduced from 50 to 100 per cent by the use of the segregation plan described in this paper and in a previous publication (1).

2. While the rate of spread of infection is materially reduced by segregating infected animals at one end of the milking string and milking them last, complete separation is necessary to entirely prevent the spread of infection.

3. Herds free from *Streptococcus mastitidis* (Group A) may be established by segregation of the normal animals, disposal of infected individuals, and replacement by first calf heifers that have not been exposed to infection following parturition.

The results presented support the opinion that it is possible to establish and maintain a herd free from the organism generally recognized as *Streptococcus agalactiae*.

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PYGOPAGUS PARASITIC BOVINE TWINS INVOLVING THE UDDER*

C. W. TURNER

From the Department of Dairy Husbandry, University of Missouri, Columbia

The frequency of twinning in cattle is rather low. Johansson (1932) in a recent survey of the literature, observed a frequency of 1.88 per cent in dairy cattle in a tabulation of 243,016 births and only 0.44 per cent in beef cattle in a tabulation of 748,855 births. Still more rare is the appearance of double monsters or conjoined twins. Johansson presented a figure of such twins preserved in the museum of the New York State Veterinary College which were joined posteriorly of the region of the diaphragm. The



FIG. 1. *Pygopagus Parasitic Bovine Twins*. The above picture shows a rare anomaly of twinning in which one member is completely represented and normal, whereas the other, a parasite, is smaller in size and in this case represented by certain posterior sections of the body.

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FIG. 2. *View of the Parasitic Udder.* In addition to the complete udder and teats there may be seen a leg and tail. Two hip points may be palpated in front of the tail. It is suggested that supernumerary mammary glands far removed from the location of the embryonic mammary line may arise as a parasitic gland from a twin which later degenerated.

anterior and free parts displayed a pronounced reversal of symmetry in color patterns. He also reported that Krönig (1924) had described 10 cases of two-headed calves and one case of "Siamese" cattle twins.

A very rare anomaly of twinning is the presence of one member which is completely represented and normal and the other, called the *parasite*, which is smaller in size and more or less imperfectly developed. The object of the present paper is to present a photograph and brief description of such a case.

The animal is owned by Mr. C. C. Burkett, of Missouri Valley, Iowa, who kindly permitted the photographs to be taken and gave the following information about the case. The animal was reported to have been dropped by a registered Guernsey cow at Persia, Iowa, in February, 1932. At the time examined (April 5, 1935) she was just over two years old. She was reported to come into estrum quite regularly although had not been bred.

As will be seen from the figures, the parasite consisted externally of a leg, tail, hip bones and a complete udder with four teats. Two of the teats were about one inch long, while the other two were quite rudimentary.

Rectal palpation disclosed another leg internally with part of the backbones and other structures as well.

The writer's special interest was in the mammary gland. Many cases of supernumerary teats have been reported in the literature. Gifford (1934) recently presented a review and added a large number of records collected in Missouri. These cases in cattle consist of additional teats and glands at the rear of or between the normal teats. Gifford found three animals with four supernumeraries at the rear of the normal teats in a population of 3582 cows examined. However, these teats were located along the embryonic mammary line (see Turner, 1930) and their position may be considered normal. The writer is not familiar with reports of either individual glands or of entire udders in abnormal locations in cattle.

In man, supernumerary nipples and glands have been reported in many positions far removed from the location of the embryonic mammary line—the thigh, the neck and back (see Deaver and McFarland, 1917, or Fitzwilliams, 1929). It has been difficult to account for such cases on the theory that they arise from proliferations of the mammary line. The case here reported suggests the possibility that such glands might arise as the result of the development of a parasitic twin, the structures of which were largely if not entirely absent with the exception of the mammary gland or glands. In other words, the presence of mammary glands in positions far removed from the location of the embryonic mammary line may be due to the fusion of the mammary gland from the parasitic twin with the normal twin, with the loss of all other parts of the parasite.

According to this theory, the supernumerary teats and glands might be classes as arising from the excessive proliferation of the mammary line or in rare cases as a parasite gland from a twin which later degenerated.

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ACCUMULATION OF PROTEIN IN THE FOAM OF SKIMMILK

PAUL F. SHARP, ROBERT P. MYERS AND E. S. GUTHRIE

Department of Dairy Industry, Cornell University, Ithaca, New York

INTRODUCTION

Gibbs, from theoretical considerations, made the deduction that the concentration of the solute at the surface might differ from that in the body of a solution, and that solutes which lower the surface energy, concentrate at the surface. This deduction was later verified experimentally. A reduction in surface tension is now accepted as evidence of the accumulation of materials at the surface of the solution. Direct evidence of accumulation is obtained by causing the solution to foam and analyzing separately the foam and the liquid beneath it.

Gibbs' deductions were based on reversible systems. Proteins lower the surface tension of their solutions and accumulate at the surface, but the process is usually not reversible, and the layer at the surface may be several molecules thick, as shown by Plateau (7), Ramsden (9), Shorter (10), and others. This accounts for the great accumulation of protein at the surface.

Siedel and Hesse (12) analyzed milk and its foam and found that protein accumulated in the foam. A summary of some of their data is given below:

	<i>Milk</i>	<i>Foam</i>
Acidity (Thörner)	15.97	18.76
Viscosity (Time of flow, min.)	69.5	75.9
Ash %	0.749	0.775
Calcium %	0.166	0.181
Dry matter %	8.68	8.99
Protein %	3.11	3.49
Specific gravity	1.0345	1.0356

The increase in total solids in the foam is almost quantitatively accounted for by the increase in protein. The increase in protein in the foam probably accounts for the increase in viscosity, specific gravity, and titratable acidity. The accumulation of calcium might be associated with an accumulation of casein.

Siedel (11) found that foam on the skimmilk from the separator was prevented by churning the milk before separation.

Rahn and Sharp (8) state that after six consecutive foamings and removals of the foam from whole milk, the liquid remaining foamed only slightly. This experiment was interpreted as indicating that the foam-producing material had been removed. The breaking of the foam at the

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end of churning and the failure of the skimmilk to foam in Siedel's experiments were interpreted as indicating that the foaming material had been irreversibly coagulated and none was left to cause foaming. Ansbacher, Flanigan and Supplee (1) eluted a protein fraction from casein which showed marked foaming properties when added to water and which was almost completely removed in the foam.

The experiments of Siedel and Hesse show that the protein content of the foam is 0.4 per cent higher than that of the milk from which it was obtained. This is an appreciable difference in protein content. If a specific protein is concentrated in the foam to the exclusion of the others, it should be a simple matter to concentrate, separate and identify it by repeatedly foaming the milk and removing the foam.

EXPERIMENTAL

Skimmilk was selected because the foam-breaking effect of the fat would not be a complicating factor. It was found that one of the best ways to produce foam on an appreciable volume of milk was to run it through the separator. Of the separators available the one which produced the most foam was selected. About 80 pounds of milk were separated at 32° C. The cream outlet of the separator bowl was then plugged and the skimmilk was rerun through the separator and was collected in a small vat with gate valve at the bottom. After standing for 5 minutes the liquid beneath the foam was drawn off and again run through the separator. This process of passing through the separator and removal of the foam was repeated from 10 to 16 times in various experiments. At intervals, samples of the milk, foam, and liquid beneath the foam were taken for analysis. Every effort was made to avoid errors due to evaporation. The vat and vessels containing the foam and milk fractions were kept covered with wet cloths.

Some of the data obtained in two series of experiments are reported. In one experiment the milk was passed through the separator 16 times at 32° C. In the other the milk was first separated at 32° C. and was then separated 13 times at 10° C.

The repeated foaming and removal of the foam did not exhaust the foam-producing capacity of the skimmilk; in fact, the foam became more stable, particularly during the first few times the milk was separated. The volumes of foam on the milk 5 minutes after separation at 32° C. are shown in Table I. This table indicates that the material which accumulated in the foam is almost entirely protein. This is in agreement with the results obtained by Siedel and Hesse.

Hekma and Brouwer (3) concluded that the separator slime came from collapsed foam cells. Van Slyke and Bosworth (14) ran milk through the separator 18 times. After the first run the composition of the slime was approximately constant. They make no comment about foaming proper-

TABLE I
Adsorption of protein in the foam of skim milk at 32° C.

NUMBER OF TIMES THROUGH SEPARATOR	MILK BEFORE SEPARATION		MILK BENEATH FOAM AFTER SEPARATION		FOAM		AMOUNT ACCUMU- LATED IN FOAM		VOLUME OF FOAM	SLIME ON OUTER BOWL COVERING	
	Protein	Total solids	Protein	Total solids	Protein	Total solids	Protein	Total solids		gram	%
1	% 3.17	% 8.58	% 3.14	% 8.79	% 3.77	% 9.39	% 0.63	% 0.60	% 27	21	0.034
2	3.14	8.79	3.14	8.82	3.68	9.47	0.54	0.65	39	8	0.016
6	3.12	8.90	3.08	8.88	3.70	9.36	0.62	0.48	42	4	0.010
8	3.02	8.81	3.00	8.83	3.68	9.56	0.68	0.73	43	4	0.010
16	2.80	8.26	2.74	8.34	2.98	8.50	0.24	0.16	50	12*	0.111
Collected foam 9 to 16 re-run	3.15	8.79	2.96	8.70	3.07	8.71	0.11	0.01	45	69	0.945

Slime from re-run foam 24.9% total solids, 20.1% protein.

* High due to souring.

ties. Table I of the present study shows that, after the first time through the separator, the amount of slime was relatively small. At the end of the experiment, however, some of the collected foam was rerun and a very large amount of slime was obtained. It is probable that the slime obtained when the foam was rerun was due to souring.

Milk was separated 13 times at 10° C., and the protein fractions were determined on every third run. The casein was precipitated with acetic acid and the nitrogen content of the resulting whey was determined. This value subtracted from the total nitrogen gave the casein by difference. An aliquot of the whey filtrate was heated to boiling at pH 5.0, cooled, and filtered. A nitrogen determination of the filtrate gave the non-heat-coagulable protein, and this value subtracted from the protein in the whey filtrate gave the heat-coagulable protein. The results obtained are presented in Table II.

Table II indicates that no appreciable change in the relative amounts of the main protein fractions of milk is produced by repeated foaming and removal of the foam. These results indicate that the proteins are concentrated in the foam in the same proportion in which they occur in milk. No indication was found that the foaming power of the skimmilk was exhausted. The percentage volume of foam was practically constant at 60 per cent after each separation in Table II.

Lots of skimmilk were re-separated 16 times at 5° and at 50° C., the foam being removed after each separation. No diminution in foaming properties was observed.

The air cells are hardly small enough to explain the marked accumulation of protein in the foam on the basis of the formation of a monomolecular layer of proteins of the albumin type. Gorter and Grendel (2) and Neurath (6) have found that 1 mg. of proteins of this type will cover about 1 square meter of surface with a complete layer one molecule thick. Leviton and Leighton (5) found that 1.7 mgm. of protein was required to cover 1 square meter of milk serum surface. With accumulations running as high as 600 mg. per 100 cc., one would have to assume 350 to 600 square meters of foam surface from 100 cc. of foam liquid.

The material which lowers the surface energy the most should be present in the outer surface layer almost to the exclusion of other materials, provided no other factor comes into play. The data in Table II show that the proteins accumulate in the foam in the proportion in which they occur in milk. No satisfactory explanation for this behavior has been found. It is possible that some specific material might form the final outer layer and our analytical procedures were too crude to reveal it. Possibly each of the proteins in milk lowers the surface energy to nearly enough the same degree that each would be crowded toward the surface. Thus the proteins might concentrate in the surface in the proportion in which they occur in milk. It is

TABLE II
Protein fractions in skimmilk after repeated separation at 10° C. (50° F.)

NUMBER OF TIMES THROUGH SEPARATOR	TOTAL PROTEIN	CASEIN		HEAT COAGULATABLE		NON-HEAT COAGULATABLE	
		Total milk	Total protein	Total milk	Total protein	Total milk	Total protein
	%	%	%	%	%	%	%
Milk before separation							
2	3.89	3.05	78.4	0.40	10.3	0.44	11.3
5	3.69	2.89	78.3	0.37	10.0	0.43	11.7
8	3.57	2.77	77.6	0.37	10.4	0.43	12.0
11	3.48	2.71	77.9	0.34	9.8	0.43	12.3
14	3.32	2.56	77.1	0.32	9.6	0.44	13.3
Collected foam re-run	3.95	3.17	80.2	0.37	9.4	0.41	10.4
Milk beneath foam after separation							
2	3.82	3.01	78.8	0.30	7.9	0.51	13.3
5	3.69	2.90	78.6	0.36	9.8	0.43	11.6
8	3.56	2.77	77.8	0.35	9.8	0.44	12.4
11	3.47	2.69	77.5	0.37	10.7	0.41	11.8
14	3.32	2.57	77.4	0.32	9.6	0.43	13.0
Collected foam re-run	3.83	3.02	78.9	0.38	9.9	0.43	11.2
Foam							
2	4.19	3.35	79.9	0.40	9.6	0.44	10.5
5	4.00	3.20	80.0	0.35	8.8	0.45	11.2
8	3.82	3.00	78.5	0.39	10.2	0.43	11.3
11	3.63	2.84	78.3	0.36	9.9	0.43	11.8
14	3.44	2.67	77.6	0.36	10.5	0.41	11.9
Collected foam re-run	4.10	3.27	79.8	0.37	9.0	0.46	11.2

further possible that the dynamic surface created by the foaming more or less "fixes" all protein material that happens to be present at the surface, at the instant of its formation. The proteins would therefore naturally be fixed or surface altered in the same proportion in which they occur in milk.

It was stated in the book by Rahn and Sharp (8) that the foaming ability of whole milk was greatly reduced by whipping, removing the foam, and rewhipping the liquid remaining. The decrease in foaming ability of the milk was explained as due to the removal of the foam-producing substance. The foaming was greatly reduced after six re-whippings. This behavior of whole milk is not in agreement with the experiments reported here on skim-milk. Therefore similar foaming experiments with whole milk were made.

Whole milk was repeatedly whipped and the foam removed in a cold room at 2° C., without any diminution of the foam. Whole milk was run through a clarifier 16 times in several series of experiments, some of which

were carried out at 10° C. and others at 32° C., without any evidence of diminution of the foam. When whole milk was whipped in the laboratory after previous cooling with ice water, and the foam allowed to drain in a cylinder in the laboratory, and this procedure was repeated several times, a diminution in the foaming was observed.

These experiments with whole milk indicate that the decrease in foaming is not due to the removal of the foaming material but to the progressive liberation of a foam-breaking agent. The foam-breaking agent is liberated from the fat by the agitation. The decrease in foaming is probably similar to that observed when the cream breaks at the end of churning. Apparently the whipping must produce churning to reduce the foaming of whole milk.

Van Dam (13) and Leviton and Leighton (5) have shown and discussed the foam-breaking effect of small amounts of milk fat. Siedel (11) has shown that the foaming of skimmilk from the separator can be prevented by churning the milk for one hour before it is separated. Separating the milk, churning the skimmilk and then recombining the churned skimmilk and the unchurned cream did not prevent the foaming of the skimmilk when the reconstituted milk was re-separated. Churning the milk with the fat present was necessary to prevent foaming.

An experiment was made in which milk was churned for three hours. The temperature of the milk at the beginning of the experiment was 12° C. At the end of two hours it had risen to 14.5° C., and when the experiment was stopped the temperature was 19° C. Samples of the churned milk were removed at 15 minute intervals, and portions were separated at both 10° and 32° C., and the amount of foam on the skimmilk measured. The results obtained are expressed graphically in Figure 1. The volume of foam obtained on the skimmilk decreased progressively with churning, up to 1½ hours. From then on the amount of foam increased progressively. The decrease in the amount of foam on the skimmilk during the first hour and a half of churning is in agreement with the observation of Siedel. The later increase, due to prolonged churning, can possibly be accounted for by further changes in the material adsorbed at the air-liquid surface. It is possible that the increased foaming after prolonged churning was due to lipase activity. Considerable lipolysis occurs when raw milk is shaken, and this usually leads to pronounced foaming. This effect is particularly marked with milk and cream from cows in advanced lactation (4).

Buttermilk ordinarily foams less than skimmilk. The failure of buttermilk to foam is probably due to the presence of fat or fat-like material liberated from the fat globules, which enters the air-liquid interface and acts as a foam breaker, thus preventing the functioning of the natural foam-forming materials which are still present in the buttermilk. This was demonstrated by churning raw sweet cream and by comparing the foaming

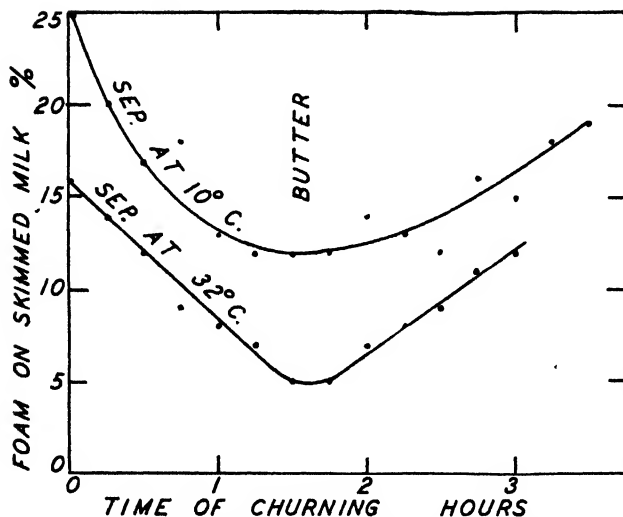


FIG. 1. Volume of foam on skimmilk, as influenced by the churning of whole milk previous to separation at 10° and 32° C.

properties of the buttermilk before and after separation and extraction with petroleum ether. The buttermilk which had been extracted with petroleum ether foamed readily at 5° and at 50° C. and appreciably at 25° C., while the natural buttermilk foamed hardly at all and the small amount of coarse foam formed soon collapsed.

CONCLUSIONS

1. Foaming and the removal of the foam, when repeated sixteen times, did not decrease the foaming capacity of skimmilk at 5°, 10°, 32°, and 50° C.
2. Protein accumulated in the foam of skimmilk to the extent of 0.12 to 0.68 per cent.
3. The relative amounts of the major protein fractions of skimmilk were not changed by repeated foaming. This indicates no preferential accumulation of any major protein fraction in the foam.
4. No decrease in the foaming properties of whole milk, due to repeated foaming, was observed unless churning occurred.
5. The foaming capacity of skimmilk separated from churned whole milk decreased progressively with the time of churning, until butter was formed.
6. The failure of buttermilk to foam readily is not due to the absence of foam-forming substances, but to the presence of foam-breaking substances.

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COMPARISON OF THE FEEDING VALUE OF STEAM DRIED AND FLAME DRIED MENHADEN FISH MEAL

M. H. BERRY¹ AND J. R. MANNING²

INTRODUCTION

Only in recent years has fish meal of a quality suitable for animal feeding become available upon the market in any considerable quantity. Considerable interest is now being shown in the use of this feed as a high protein supplement in animal feeding. Fish meal is also a valuable source of vitamins and minerals.

Investigations have shown that fish meals are superior to some meat by-products feeds in general feeding value and as sources of protein (1). In feeding trials with dairy cows in which fish meal has been used as a protein concentrate, it has compared very favorably with cottonseed, soybean and linseed oil meals (2), (3), (4), (5), (6). In rations for calves and young stock, fish meal has proved very satisfactory as a source of protein when compared with such protein supplements as linseed oil meal, tankage and blood flour. (5), (7).

METHODS OF MANUFACTURE

There are several widely differing processes of drying fish meals. The heat for drying may be supplied either by direct flame or by steam and the resulting products correspondingly termed "flame dried" or "steam dried" fish meal.

Daniel and McCollum (1) have shown in a series of experiments with rats, that vacuum or steam dried meals are superior to flame dried meals in feeding qualities. The findings of other investigators, (8), (9), (10) working with small animals and poultry, substantiate these statements and offer additional information.

At present, very little, if any, data are available showing the relative feeding value for large animals of fish meals produced by either of these drying methods.

It is the purpose of this paper to report the results of two feeding trials with growing heifers comparing the feeding value of flame dried and steam dried menhaden fish meal.

EXPERIMENTAL

Two separate feeding trials, each 120 days in length, were conducted, using animals from the Maryland Experiment Station herd. The work was started during the winter of 1934-35 and repeated the winter of 1935-36.

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¹ Maryland Agricultural Experiment Station.

² U. S. Bureau of Fisheries.

The same general plan was used in conducting both trials. In both trials, the heifers were divided into two groups as similar as possible with respect to breed, age, live weight and general body condition. In Trial I, there were eight heifers per group. In Trial II, there were nine heifers in each group. Each group was quartered and fed in a large box stall in a shed. They were turned out daily for exercise, when the weather was favorable.

Group feeding was practiced throughout both trials. Six pounds of clover hay (U. S. No. 2 grade), and four pounds of a grain ration composed of two parts ground yellow corn, one part wheat bran and one part fish meal were fed daily per heifer. Fish meal, fed at the rate of one pound per day per heifer, made up 10 per cent of the total daily ration fed. Salt was kept before the animals in their feed troughs. Fresh water was accessible at all times.

Individual weights were taken for three consecutive days at the beginning and again at the end of the experimental periods and the average of the three weights taken as the initial and the final weight per heifer. An individual weight was also taken at the end of the first, second and third months.

COMPOSITION OF MEALS

Table I gives the analyses of the fish meals used in both feeding trials. In Trial I, two different lots of each meal were fed during the feeding period. In Trial II, one lot of the same meal was used throughout the experiment

TABLE I
Analyses of menhaden fish meals used in feeding trials

	TRIAL I (1934-35)				TRIAL II (1935-36)	
	Steam dried		Flame dried		Steam dried	Flame dried
	<i>Lot I</i>	<i>Lot II</i>	<i>Lot I</i>	<i>Lot II</i>		
Protein (N \times 6.25)	62.50	63.50	60.12	62.81	61.54	60.57
Moisture	7.60	7.14	6.48	6.88	9.14	9.28
Ash	19.37	14.64	19.67	19.55	17.34	19.24
Ether Extract	3.61	5.71	4.63	6.62	10.63	9.91
Undetermined	6.92	9.01	9.10	4.14	1.35	1.00
Total	100.00	100.00	100.00	100.00	100.00	100.00

It will be noted that the ether extract values are especially low and the percentage of undetermined constituents unusually high in the meals fed in Trial I. The fat content of menhaden fish meal ranges normally from 8 to possibly 12 per cent. It is believed that the low ether extract values of the

meals fed in Trial I are due to the fact that during storage a considerable proportion of this fat became oxidized and hence was not extractable by ordinary laboratory procedure. The samples of the meals fed in Trial I were not taken until after the close of the feeding trial. The samples of the meals fed in Trial II were taken during the feeding period and the analyses are therefore a true indication of their composition at the time they were fed.

DISCUSSION OF RESULTS

Complete results of the two feeding trials are reported in Table II.

It will be noted that in both trials the flame dried group made slightly larger average daily gains in weight than the steam dried group. This difference, however, is not significant.

At the conclusion of the first feeding trial, conducted during 1934-35 there was a decided difference in general body condition and appearance between the two groups of heifers, the advantage being in favor of the group fed the flame dried fish meal. The group fed the flame dried product was in a fine condition of flesh and presented a very smooth, thrifty appearance throughout the trial. The heifers in the group receiving the steam dried fish meal were in a poor state of flesh at the end of the trial and presented a very rough, unthrifty appearance. No definite reason could be ascertained for this lack of flesh and general unthrifty appearance.

As it seemed best to secure additional data, the trial was repeated during the winter of 1935-36.

The growth results secured in Trial II were practically the same as those secured in Trial I although the heifers were slightly older. The rough,

TABLE II
Tabulation of results
All weights expressed in pounds

	TRIAL I		TRIAL II	
	Steam dried group	Flame dried group	Steam dried group	Flame dried group
Number of heifers per group	8	8	9	9
Number of days on trial	120	120	120	120
Av. initial age per heifer (months)	11.47	10.96	14.33	13.80
Av. initial weight per heifer	434.37	434.50	522.77	523.22
Av. final weight per heifer	548.12	558.87	632.11	647.33
Av. total gain per heifer	113.75	124.37	109.34	124.11
Av. daily gain per heifer	.94	1.03	.91	1.03
Daily ration fed per heifer				
Fish meal	1	1	1	1
Bran	1	1	1	1
Corn meal	2	2	2	2
Hay (U. S. #2 clover)	6	6	6	6
Total	10	10	10	10

TABLE III
Individual weight results—Trial I
Steam Dried Group
(All weights expressed in pounds)

HEIFER	INITIAL WEIGHTS				1ST MO.	2ND MO	3RD MO	FINAL WEIGHTS (4TH MONTH 120 DAYS)				GAIN IN WEIGHT	AV DAILY GAIN
	1st day	2nd day	3rd day	Average				1st day	2nd day	3rd day	Average		
508	470	477	480	475	510	565	595	620	630	640	630	155	1.29
511	440	445	452	445	474	513	548	565	560	567	564	119	.99
512	405	407	409	407	425	435	465	481	483	482	482	75	.62
517	455	453	457	455	517	550	590	627	628	628	628	173	1.44
519	426	423	422	423	446	470	505	510	511	515	512	89	.74
522	385	387	389	387	405	400	430	452	450	460	454	67	.55
524	370	370	371	370	380	410	458	492	500	492	494	124	1.03
534	510	515	515	513	535	550	587	621	624	620	621	108	.90

* Flame Dried Group

505	483	495	500	492	549	588	610	625	630	637	630	138	1.15
507	492	496	498	495	560	580	595	627	625	630	627	132	1.10
513	437	441	446	441	474	505	535	548	545	555	549	108	.90
514	415	410	408	411	447	475	505	525	420	538	527	116	.96
518	465	463	464	464	535	562	590	591	598	605	598	134	1.11
520	410	410	407	409	440	485	518	560	550	552	554	145	1.20
521	342	342	343	342	361	390	407	409	415	413	412	70	.58
523	420	422	425	422	461	510	545	570	575	578	574	152	1.26

TABLE III
Individual weight results—Trial II
 Steam Dried Group
 (All weights expressed in pounds)

HEIFER	INITIAL WEIGHTS				2ND MO.	3RD MO.	FINAL WEIGHTS (4TH MONTH 120 DAYS)				GAIN IN WEIGHT	AV. DAILY GAIN
	1st day	2nd day	3rd day	Average			1st day	2nd day	3rd day	Average		
519	726	740	734	733	750	800	891	882	895	899	156	1.30
525	640	635	635	636	643	665	680	681	675	678	42	.35
527	601	612	610	607	607	610	665	672	664	665	58	.48
529	680	692	696	689	711	745	773	785	774	781	92	.76
531	503	505	511	506	515	535	590	619	620	614	111	.92
532	458	462	460	460	496	519	611	606	610	609	149	1.24
536	423	422	426	423	435	475	532	537	532	533	110	.91
538	330	326	326	327	376	416	467	471	472	470	143	1.19
539	325	323	325	324	355	395	445	453	443	447	123	1.02
Flame Dried Group												
521	653	666	663	660	650	680	678	725	726	714	61	.50
524	702	711	714	709	755	831	848	900	897	895	188	1.56
528	583	580	590	584	614	642	660	696	697	690	110	.91
530	659	660	655	658	665	705	730	778	777	775	118	.98
533	535	537	536	536	545	560	581	615	625	620	84	.70
535	428	434	436	432	455	470	510	518	517	517	85	.70
537	443	440	444	442	486	523	565	587	591	590	144	1.20
540	325	320	328	324	375	416	455	491	494	493	169	1.40
541	367	357	368	364	415	457	483	518	520	522	158	1.31

unthrifty appearance and lack of condition that was evident with the heifers in the steam dried group in Trial I did not appear in Trial II. No differences in the condition of the animals on the two different meals in the second trial were apparent to the eye.

No difficulty was experienced in getting the heifers to eat readily the grain ration containing fish meal.

SUMMARY AND CONCLUSIONS

The comparative feeding value of steam dried and flame dried menhaden fish meal was determined by conducting two separate 120-day feeding trials during two successive years with two groups of yearling heifers. Fish meal made up 10 per cent of the total ration fed daily per heifer.

There was no significant difference between the two meals in either trial in respect to gains in weight produced. The only difference was the better general body condition of the animals in the flame dried group in Trial I. There was no apparent difference in body condition or physical appearance of the two groups in Trial II.

No difference was noted in the palatability of the two meals

Insofar as the results secured from this series of feeding trials are concerned, it was definitely demonstrated that there was no difference in growth-promoting properties between the two meals when fed on an equal weight basis.

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OXIDIZED FLAVOR IN MILK

II. THE EFFECTS OF HOMOGENIZATION, AGITATION AND FREEZING OF MILK ON ITS SUBSEQUENT SUSCEPTIBILITY TO OXIDIZED FLAVOR DEVELOPMENT*

L. M. THURSTON,¹ W. CARSON BROWN,¹ AND R. B. DUSTMAN²

West Virginia Agricultural Experiment Station, Morgantown

Evidence that lecithin, rather than butter fat, may be the constituent of milk affected when oxidized flavor develops, was presented in the first of this series of studies on oxidized flavor (7). In continuing a study of the probable relation of lecithin to oxidized flavor development it was considered that processes which disturb the adsorbed layers on the fat globules might have some effect on the susceptibility of the milk to the development of this flavor.

There can be little doubt that homogenization of milk probably causes changes in the distribution of the materials adsorbed on the fat globules. Furthermore, Tracy, Ramsey and Ruehe (8) have shown that homogenization of milk lessens the intensity of the oxidized flavor that can be developed by the addition of copper followed by storage for 24 hours at 40° F. They state that the close relationship between the Eh values of the homogenized and non-homogenized milks indicates that the lessened intensity of the oxidized flavor developing in homogenized milk needs to be explained in some other way than on an oxidation-reduction basis.

Lundstedt (4) has presented evidence that the vigorous, mechanical agitation of milk while cold causes a movement of lecithin from the adsorbed layers on the fat globules to the plasma portion of the milk. Such a change might be expected to affect the susceptibility of the milk to oxidized flavor development if lecithin is the constituent oxidized when this flavor occurs.

Freezing and thawing probably cause some changes in the adsorbed layers on the fat globules as is evidenced by the oiling off of some of the

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¹ Department of Dairy Husbandry.

² Department of Agricultural Chemistry.

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butter fat when frozen milk is melted too rapidly. Doan and Baldwin (1) have shown that considerable pressure is exerted within cream when it freezes and conclude that this pressure is the causative factor of most importance in the destruction of the fat emulsion.

To test the effects of these processes on the susceptibility of milk to oxidized flavor development, the experiments herein reported, involving homogenization, agitation at low temperature, and freezing followed by thawing were carried out.

EXPERIMENTAL

The effect of homogenization. Homogenization of both raw and pasteurized milks was carried out at pressures ranging from none to 5,000 pounds per square inch. Samples of each batch of milk taken before passage through the homogenizer served as control samples. A sixty gallon per hour, single stage homogenizer was equipped with a 5-gallon supply tank having an outlet at the bottom to which was attached a sanitary fitting connected to the intake line of the machine. After the control sample was taken, the milk to be homogenized was placed in the supply tank and passed through the machine, first with no pressure applied and then with successive increases in pressure. Before the taking of each homogenized sample sufficient time was allowed for the milk homogenized at each increased pressure to reach the end of the short delivery pipe after leaving the homogenizing valve.

The pasteurization was carried out at $144^{\circ}\text{F.} \pm 1^{\circ}$ with a 30-minute holding period. The pasteurized milk was homogenized immediately after the holding period without reduction in temperature other than that resulting while the milk was being brought to the homogenizer. The first five milks studied were from the mixed milk produced by the Experiment Station herd, and were drawn from a 150-gallon chromium-nickel-steel pasteurizer at the end of the holding period. The valve of the pasteurizer was made of brass, however, and a tendency for the development of oxidized flavor in this milk without the addition of copper other than that contaminating it while passing through the valve soon was apparent. The remaining milks studied were from cows selected because their milks were known to be susceptible to oxidized flavor development. The milk was drawn into aluminum buckets, cooled in an aluminum can immersed in ice water, and pasteurized later in the same can by immersion in a tank equipped with a cold water and a steam-inlet.

Raw milks studied were from cows selected as described above. The milks were drawn and held in aluminum utensils. They were homogenized at 90 to 100°F.

Each sample of milk was divided into two portions and a known amount of copper, as copper sulphate dissolved in water, was added to one portion. The concentration of the copper sulphate solution added was so regulated

that not more than 2 ml. of the solution per quart of milk was necessary when making additions of 1.3 and 2.6 parts per million of copper. Following this treatment the samples were stored for three days at about 40° F., according to the method of Guthrie and Brueckner (2), after which the occurrence of oxidized flavor was determined by taste.

The results of these studies are shown in Table 1.

The non-homogenized samples to which no copper had been added and which were not contaminated with copper by contact with surfaces exposing this metal did not become oxidized in flavor, but milks 1 to 5 inclusive evidently were contaminated sufficiently when passing through the brass valve of the pasteurizer to cause them to become oxidized. The development of oxidized flavor in all the non-homogenized samples to which copper was added shows that these milks were susceptible with respect to oxidized flavor. The tendency for the milks passed through the homogenizer without pressure to develop this flavor is evident, and is to be explained on the basis of copper contamination from the cylinder block and valves of the machine in the cases where no previous contamination had occurred. However, homogenization at pressures as low as 500 pounds either reduced the intensity of the oxidized flavor resulting after the addition of copper or prevented it altogether. In no case was oxidized flavor developed in milks containing added copper when the homogenizing pressure was 3000 pounds or more. As was expected, the homogenization of raw milk samples caused the development of very pronounced rancid and bitter flavors.

The effect of agitation. In order to obtain information on the effect of agitation of cold milk on the transfer of lecithin from the adsorbed layers on the fat globules to the plasma, in addition to that furnished by Lundstedt, three trials were carried out in which milk kept at 33° F. was agitated vigorously for two and one-half hours by means of a Lightnin mixer. Samples of agitated and non-agitated milk from the same original source, were separated and the lecithin content of each sample was determined by the method of Horrall (3). In order to make the results comparable each cream was standardized to 40 per cent butter fat on the basis of the Babcock test, with the skimmilk just separated from it.

The results of this study are shown in Table 2. An examination of the data shows that in each of the three cases agitation caused a reduction in the lecithin content of the cream and a corresponding increase in the lecithin content of the skimmilk. These results indicate that agitation did cause a movement of a portion of the lecithin adsorbed on the fat globules to the plasma. If the skimmilk had contained no butter fat whatever its lecithin content might be expected to show the amount of non-adsorbed lecithin occurring in the plasma portion of the milk, provided also that no movement of lecithin between the adsorbed layers on the fat globules and the plasma occurred as the result of warming and separating the milk. Considering

TABLE 1
The effect of homogenizing milk on its susceptibility to the development of oxidized flavor

TREATMENT	COPPER ADDED (P.P.M.)	MILKS PASTEURIZED IN 150-GALLON PASTEURIZER						MILKS PASTEURIZED IN ALUMINUM CANS										RAW MILKS			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		
Not homogenized	None	4	1	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1.3	4	4	3	2	4	4	1	-	-	-	-	-	-	-	-	-	-	-	-	-
	2.6								4	3	4	4	4	4	3	5	3	4	5		
Homogenized, no pressure	None				4	4	-	-	-	-	-	3	4	-	4	3	-	1	3		
	1.3				2	2	2		1	1	3	3	3		3	2	3	1	4		
	2.6								-	-	1	-	-	2	-	-	-	-	-		
Homogenized, 500 pounds	None				-	-	-		-	-	-	-	-	-	-	-	-	-	-		
	1.3				-	-	1		-	-	3	2	3	2	3	-	-	-	-		
	2.6								-	-	-	-	-	-	-	-	-	-	-		
Homogenized, 1000 pounds	None				-	-	-		-	-	-	-	-	-	-	-	-	-	-		
	1.3				-	-	-		-	-	-	-	-	-	-	-	-	-	-		
	2.6				-	-	-		-	-	2	1	1	1	1	-	-	-	-		
Homogenized, 1500 pounds	None				-	-	-		-	-	-	-	-	-	-	-	-	-	-		
	1.3				-	-	-		-	-	-	-	-	-	-	-	-	-	-		
	2.6				-	-	-		-	-	-	1	1	-	-	-	-	-	-		
Homogenized, 2000 pounds	None				-	-	-		-	-	-	-	-	-	-	-	-	-	-		
	1.3				-	-	-		-	-	-	-	-	-	-	-	-	-	-		
	2.6				-	-	-		-	-	-	-	-	-	-	-	-	-	-		
Homogenized, 3000 pounds	None				-	-	-		-	-	-	1	-	-	-	-	-	-	-		
	1.3				-	-	-		-	-	-	-	-	-	-	-	-	-	-		
	2.6				-	-	-		-	-	-	-	-	-	-	-	-	-	-		
Homogenized, 4000 pounds	None				-	-	-		-	-	-	-	-	-	-	-	-	-	-		
	1.3				-	-	-		-	-	-	-	-	-	-	-	-	-	-		
	2.6				-	-	-		-	-	-	-	-	-	-	-	-	-	-		
Homogenized, 5000 pounds	None				-	-	-		-	-	-	-	-	-	-	-	-	-	-		
	1.3				-	-	-		-	-	-	-	-	-	-	-	-	-	-		
	2.6				-	-	-		-	-	-	-	-	-	-	-	-	-	-		

Meaning of symbols: -, no oxidized flavor; †, may or may not have been oxidized; 1, very slight oxidized flavor; 2, slight oxidized flavor; 3, moderate oxidized flavor; 4, fairly pronounced oxidized flavor; 5, pronounced oxidized flavor; 6, very pronounced oxidized flavor; x, rancid and bitter.

The effect of agitating milk for two and one-half hours with a Lightnin mixer on the percentage of lecithin in the cream and skimmilk subsequently separated

MILK NO.	TREATMENT	CREAM		SKIMMILK	
		Butterfat*	Lecithin	Butterfat*	Lecithin
		<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>
1	Not agitated	40	.1673	.03	.0148
	Agitated	40	.1118	.03	.0168
2	Not agitated	40	.1618	.025	.01225
	Agitated	40	.1503	.02	.0126
3	Not agitated	40	.1898	.025	.01135
	Agitated	40	.1535	.025	.0122

* Determined by Bubeock method.

the skimmilk as fat-free, and assuming that no movement of adsorbed lecithin or plasma-lecithin took place as the result of warming and separating the milk, the movement of lecithin from the adsorbed layers on the fat globules to the plasma could be calculated in the case of milk No. 1 as follows:

$$\frac{[.1673 - (60 \times .000148)] - [.1118 - (60 \times .000168)]}{.1673 - (60 \times .000148)} \times 100 = 35.8 \text{ per cent}$$

The corresponding percentages for milks Nos. 2 and 3 would be 7.6 and 20.1 respectively.

Even allowing for errors in the assumptions made, a movement of lecithin from the fat globule surfaces to the plasma as the result of agitation is indicated by these results. The variations in the values obtained suggest that the different milks may have contained different amounts of adsorbed lecithin before they were agitated, or that there were differences in the effectiveness of agitation possibly as the result of variations in the amount of milk in the container in which the agitation was carried out.

The effect of agitating for 2½ hours with a Lightnin mixer on the susceptibility of milk to the development of oxidized flavor was determined also. Milks from cows known to be producing susceptible milks were drawn and handled in aluminum utensils until the end of the process of agitation, when a sample containing no added copper and samples containing 1.3, 2.6, and 3.9 parts per million of added copper, respectively, were stored in milk bottles for three days at about 40° F. and then tasted. Nine samples of pasteurized milk and five samples of raw milk were studied. Pasteurization was carried out in aluminum cans in the manner already described in the discussion of the homogenization studies.

The results of this study are recorded in Table 3.

TABLE 3

The effect of agitating milk on its susceptibility to the development of oxidized flavor

MILK	FLAVOR OF NON-AGITATED SAMPLES		FLAVOR OF AGITATED SAMPLES			
	No copper added	2.6 p.p.m. added cu	No copper added	1.3 p.p.m. added cu	2.6 p.p.m. added cu	3.9 p.p.m. added cu
Pasteurized Milks						
1	—	5	—*	—*	—*	1*
2	—	4	—*	—*	—*	—*
3	—	4	—*	—*	2*	2*
4	—	6	—*	—*	1*	3*
5	—	6	—*	—	1	2
6	—	5	—*	—*	1*	3*
7	—	5	—*	—*	—*	1*
8	—	5	—*	—*	—*	3*
9	—	4	—*	—*	—*	1*
Raw Milks						
10	—	4	—X	—X	—X	—X
11	—	5	—X	—X	—X	—X
12	—	6	—X	—X	—X	—X
13	—	5	—X	—X	—X	—X
14	—	5	—X	—X	—X	—X

* Cream plug. X Slight rancid flavor.

For explanation of other symbols see Table 1, footnotes.

All milks in this series were agitated two and one half hours with a Lightnin mixer. The container was immersed in ice water during agitation.

The results recorded in Table 3 show that, although the milks used were highly susceptible to oxidized flavor development before they were agitated, nevertheless prolonged agitation greatly reduced or eliminated this susceptibility. Extensive changes at the fat globule surfaces are indicated by the fact that the agitation of raw milks caused the subsequent development of rancid flavor in every case. Cream plugs, formed on all the pasteurized milks, also indicate that changes at the fat globule surfaces occurred as the result of agitation. Examination under the microscope showed many of the fat globules to be irregular in shape and some of them to be coalesced.

Agitation for two and one-half hours constitutes rather drastic treatment. To determine the effects of varying times of agitation, relatively large samples were agitated for a two and one-half hour period and samples were removed 5, 15, 30, 45, 60, 90, 120, and 150 minutes, respectively, after agitation was begun. The susceptibility of the milks agitated for the varying lengths of time was determined as before. Three pasteurized and three raw milks were studied in this experiment.

The results, recorded in Table 4, show little effect of agitation on susceptibility until the milks had been agitated for 45 minutes or longer. Agitation for 150 minutes (two and one-half hours) made the milks non-susceptible

TABLE 4

The effect of length of agitating period on the susceptibility of milks to oxidized flavor development

STIRRING PERIOD	COPPER ADDED (P.P.M.)	PASTEURIZED MILKS			RAW MILKS		
		1	2	3	1	2	3
Not agitated	None	—	—	—	—	—	—
Not agitated	2.6	6	4	5	4	4	5
5 minutes	2.6	4	3	4	2	3	4
15 minutes	2.6	4	3	4	2	3	4
30 minutes	2.6	3	3	3	2	3	3
45 minutes	2.6	1	3	3	1	2	3
60 minutes	2.6	1	2	—*	1	2	2
90 minutes	2.6	1	1*	—*	1	2	2
120 minutes	2.6	??	—**	—**	?	1x	—x
150 minutes	2.6	—*	—**	—**	—x	—x	—x

* Slight cream plug. ** Moderate cream plug. x Slight rancid flavor.

For meaning of other symbols see Table 1, footnotes.

in these trials. A close relationship between the formation of a cream plug and the reduction in susceptibility is evident. Samples of raw milk No. 1 not agitated and agitated for 5, 60, and 150 minutes, respectively, were examined under the microscope. The sample agitated 60 minutes showed only slight evidence of churning, but definite evidence of churning was apparent in the sample agitated 150 minutes. No cream plugs occurred on the raw milk samples after agitating. It is interesting to note also that slightly rancid and bitter flavors occurred in all the raw milk samples that had been agitated for 150 minutes and in some of these samples after 120 minutes of agitating.

The effect of freezing and thawing. In studying the effect of freezing and thawing on the susceptibility of milks to oxidized flavor development, milks were used from cows known to be producing susceptible milks. The milks were handled entirely in aluminum and glass containers. As in the other experiments herein reported, the susceptibility of the milks was determined by the addition of copper sulphate solution in concentrations such that the addition of not to exceed 3 ml. of the solution per quart of milk was necessary to yield the concentrations of added copper desired. Samples were frozen in aluminum cans in still air at 0° F. by storage at this temperature for 24 hours. They were thawed at 70° F. with a minimum of agitation, after which they were cooled in ice water. Four samples of milk that had been frozen and thawed were prepared in quart milk bottles containing no added copper and 1.3, 2.6, and 3.9 parts per million of added copper, respectively. After preparation all samples were stored 3 days at about 40° F. and then tasted.

The results of this experiment, recorded in Table 5, show that freezing and thawing under the conditions obtaining caused the reduction or elimina-

TABLE 5
The effect of freezing and thawing on the susceptibility of milk to oxidized flavor development

MILK NO.	NOT FROZEN				FROZEN AND THAWED			
	Parts per million added cu				Parts per million added cu			
	None	1.3	2.6	3.9	None	1.3	2.6	3.9
Raw Milks								
1	-	-	1	1	-	-	-	1
2	-	3	3	3	-	*	*	2*
3	-	4	3	2	*	*	*	*
4	-	1	3	2	*	*	**	**
5	-	3	3	3	-	*	1*	1*
6	-	3	4	2	-	2*	2*	2*
7	-	2	3	3	-	2	3	2*
Pasteurized Milks								
1	-	2	2	2	*	*	*	*
2	-	4	3	2	*	2*	2*	1*
3	-	4	3	3	*	*	*	1*
4	-	3	2	2	**	**	**	1*
5	-	5	2	2	-	2	1	2
6	-	4	4	3	*	**	**	**
7	-	2	2	2	**	**	**	**

* Slight cream plug. ** Excessive cream plug.

For meaning of other symbols see Table 1, footnotes.

tion of the susceptibility of the milks to oxidized flavor development. A close relationship between this effect and the occurrence of cream plugs containing relatively large particles of butter fat, that presumably oiled off during thawing, was observed. Whenever an excessive cream plug was observed the milk failed to develop oxidized flavor even with 3.9 parts per million of added copper, but when a less pronounced cream plug was observed some development of oxidized flavor usually was evident.

SUMMARY AND DISCUSSION

The results of these studies show that treatments of milk by homogenization, by agitation at low temperature, and by freezing and thawing have marked effects in reducing or eliminating the susceptibility of milk to oxidized flavor development when stored after addition of sufficient copper to cause the development of oxidized flavor in the non-treated milk. Also, vigorous, prolonged agitation of milk at low temperature was shown to cause some movement of lecithin from the adsorbed layers on the fat globules to the plasma.

A consideration of these experiments does not yield any clear-cut explanation of the phenomena observed. The work of Tracy, Ramsey and Ruehe (8) indicates, as already pointed out, that the effect of homogenization in lessening the susceptibility of milk to oxidized flavor development is not to be explained on the basis of changes in the oxidation-reduction potential. The striking similarity in the effects of each of the three treatments, *i.e.*, homogenization, agitation and freezing followed by thawing, appears to be that each probably causes at least some realignment of the materials adsorbed on the fat globules. Lecithin undoubtedly is concerned in this realignment as was shown in the experiments studying the effects of agitation. However, the manner in which either the lecithin or the butter fat may be protected from oxidation as the result of these treatments is not evident.

If a transfer of nearly all the lecithin from the adsorbed layers on the fat globules to the plasma were caused by these treatments, a conclusion would be indicated that lecithin in the adsorbed layers on the fat globules is oxidized readily to give rise to oxidized flavor, whereas lecithin dispersed in the plasma, but not adsorbed on the fat globules, is not oxidized in this manner. Evidence that lecithin in the plasma is not affected to produce oxidized flavor was obtained in three trials with milk and with sweet-cream buttermilk from cream separated from the same milk. Samples of milks obtained and handled in the same manner as in the experiments on freezing were pasteurized, cooled and stored at 40° F. for three days after the addition of known amounts of copper as in the experiments herein reported. All three milks were found to be susceptible. Each milk, free from previous contamination with copper or iron, was separated by means of a De Laval separator and churned by shaking in a small aluminum can. The cream was churned at low temperature and the process was carried out in a room kept at about 40° F. Gloves were worn during the shaking process to avoid appreciable heat transfer to the cream. It was hoped that by observing these precautions very exhaustive churning would result. The buttermilks obtained were tested for their susceptibility to oxidized flavor development by the method used for the milks in the preceding experiments.

The results are shown in Table 6. Buttermilk from milk No. 1 was relatively low in butter fat content (0.6 per cent) and the buttermilk from milk No. 2 was exceedingly low in butter fat content (0.035 per cent). Neither of these buttermilks developed oxidized flavor. Although a metallic taste was quite evident in both buttermilks containing either 2.6 or 3.9 parts per million of copper, their flavor was entirely unlike the oxidized flavor developed in the milks which were the sources of these buttermilks. The buttermilk from milk No. 3 contained 3.8 per cent of butterfat, and a very slight but typical oxidized flavor was evident in the samples containing 2.6 and 3.9 parts per million of added copper. As churning is known to cause

TABLE 6
The susceptibility of sweet cream buttermilk to oxidized flavor development

MILK NO.	ORIGINAL MILK: FLAVOR				BUTTERMILK: BUTTER FAT CONTENT AND FLAVOR				
	Copper added (p.p.m.)				Butter fat*	Copper added (p.p.m.)			
	None	1.3	2.6	3.9		None	1.3	2.6	3.9
1	—	4	2	2	<i>per cent</i> 0.6	—	—	—	—
2	—	4	3	2	0.035	—	—	—	—
3	—	3	2	1	3.8	—	—	1	1

* Determined by Babcock method.

For meaning of other symbols see Table 1, footnotes.

the removal of most of the adsorbed lecithin from the fat globules and its dispersion in the buttermilk these investigations indicate that lecithin, when not adsorbed at the fat globule surfaces, may not be oxidized to produce the typical oxidized flavor. The development of oxidized flavor in the buttermilk from milk No. 3 may be explained on the basis that because of its relatively high butterfat content, a considerable number of fat globules remained on which, presumably, the lecithin was oxidized to produce the oxidized flavor noted. Reference was made in the first of this series of articles to the fact that Thurston and Barnhart (6) observed the occurrence of oxidized flavor in sweet cream buttermilk. It should be noted that the buttermilks produced in those experiments probably contained some non-churned butterfat and therefore would be expected to show oxidized flavor development in the same manner as did sample No. 3 in this experiment.

It must be recognized that the transfer of lecithin from the fat globules to the plasma as the result of agitation was far from quantitative in the case of these experiments, and that the probability of such a transfer as the result of homogenization or of freezing and thawing is extremely remote. However, it appears from these experiments with churning that any lecithin so transferred would not be affected so as to produce oxidized flavor.

The possible significance of the formation of cream plugs in all pasteurized milks that were agitated 120 minutes or longer, and in nearly all the milks that were frozen and thawed, deserves consideration. Sommer and Royer (5) have shown that cream plug formation is the result of partial churning. This fact would suggest that the transfer of some lecithin from the adsorbed layers on the fat globules to the plasma as the result of agitation or of freezing and thawing is caused by partial churning, as churning is known to have this effect. However, as only partial churning occurred and only part of the lecithin was shown to move from the fat globules to the plasma in severely agitated milk it would seem that the partial churning observed cannot account for the complete protection of the milk from

oxidized flavor development. The data herein reported do not yield an adequate explanation of this point.

It is likely that freezing of milk followed by thawing does not have so extreme an effect as severe mechanical agitation. The data show that many of the milks frozen and thawed were reduced in their susceptibility to oxidized flavor development but were not rendered entirely non-susceptible. This fact would suggest that the reduction in susceptibility was the result of the freeing of lecithin from coalesced fat globules but that other fat globules remained unchanged and permitted the development of oxidized flavor.

Although homogenization has the same effect in rendering milk non-susceptible to oxidized flavor development as severe mechanical agitation and freezing followed by thawing, the effect of homogenization on the physical constitution of milk is so different from the effects of the other two treatments studied that it would be difficult to explain all these effects on the same basis. A number of possibilities have been considered, but as they lack foundation in experimental demonstration they are left for future study.

CONCLUSIONS

Homogenization, prolonged agitation at low temperature, and freezing and thawing of milk reduce or eliminate its susceptibility to oxidized flavor development.

These results seem to lend support to the previous evidence obtained by the authors that lecithin rather than butterfat probably is the constituent of milk affected when oxidized flavor develops.

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THE INFLUENCE OF THE PHYSICAL STATE OF THE FAT ON THE CALCULATION OF SOLIDS FROM THE SPECIFIC GRAVITY OF MILK

PAUL F. SHARP AND RAY G. HART

Department of Dairy Industry, Cornell University, Ithaca, New York

INTRODUCTION

At least 36 different equations for calculating the relationship between the specific gravity and the fat and plasma solids content of milk have been published in the past 75 years. The first equations proposed dealt with the determination of the fat content from the specific gravity and the total solids content, because at that time no simpler method for the determination of fat in milk was available. With the development of the Babcock and Gerber methods for the determination of fat, the use of the equation shifted to the determination of the total solids, or plasma solids, from the fat content and the specific gravity.

It has been a rather common observation that the equations work well only when applied to the data from which they are derived. They usually fail, particularly when used by another investigator. This has led to the substitution of a long list of different constants in the fundamental equation expressing this relationship, and to the addition or subtraction of arbitrary constant factors to make the calculated results agree with the experimentally determined values.

It is surprising that such variations should exist in the proposed equations for expressing a simple relationship between apparently simple physical constants. The existence of unrecognized and uncontrolled variables in the system is indicated.

A large part of this lack of agreement and reproducibility is due to one factor which has never been limited adequately, namely, the lag in the change in the physical state of the fat in the globules as the temperature is adjusted to that at which the specific gravity is determined. The determinations are almost invariably made at 60° F. (the temperature specified by health and food officials of the United States) or at 15° C. in some parts of Europe. With or without limitations as to the previous heat treatment of the milk, work in this laboratory has indicated that a more unsatisfactory temperature for making the specific gravity determinations could not be found. Fat in the globules of milk does not melt or dissolve and solidify or crystallize as the temperature is changed, as rapidly as does milk fat in mass. Since each globule is an isolated unit, crystallization of one globule does not by seeding induce crystallization in any other globule. Conse-

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quently there is a much greater lag in the melting and particularly in the solidification of the fat in the globules as contrasted to the change in physical state of fat in mass. This lag in both effects is at a maximum in the region of 15°C . A sample of milk which has been held cold for some time and then is warmed to 15°C . will have a greater specific gravity than a sample of the same milk which has been held warm and is then cooled to 15°C . This difference is due to the fact that the fat in one case is mostly in the solid state at 15°C . and in the other mostly in the liquid state. Solid fat at this temperature has a higher specific gravity than does liquid fat at the same temperature.

The expected variations in the physical state of the fat explain the following observations which have been reported in the literature:

(1) That night's milk is more dense than morning's milk (the determinations of the morning's milk being made soon after milking, while the evening's milk was held over night in a refrigerator).

(2) That winter's milk is more dense than summer's milk (the milk being cooled more in winter).

(3) That correction factors fail to give satisfactory results when the specific gravity is determined at some temperature other than 15°C . and is then corrected to 15°C .

(4) That the specific gravity of milk increases with age (the milk being kept cold).

The fact that the specific gravity of milk increases on standing has been known for about 80 years. The textbooks on dairying refer to this increase in specific gravity as Recknagel's phenomenon. Recknagel (2) determined some of the conditions under which the increase in specific gravity occurred. He showed that the escape of air bubbles was not the factor, but attributed the increase in specific gravity to an increase in the hydration of the casein at the lower temperatures. He did not study skim-milk. Toyonaga (5), working with Soxhlet, attributed the increase to the solidification of the fat and reported that the process could be repeated by warming and again cooling. He found that almond oil when emulsified in a gum solution showed no increase, whereas a 4% emulsion of milk fat in gum solution showed the same increase in specific gravity on standing at 15°C . as did whole milk. Richmond (3) states that Recknagel's phenomenon is due largely to the increase in density of the fat.

In several cases it has been possible to learn the previous history of the samples of milk used by investigators in developing their equations, and in each case the previous history of cooled or warmed milk was reflected in the constants of the equation proposed.

This investigation was undertaken to show that much of the previous difficulty in establishing the relation between the specific gravity of milk

and its composition could be accounted for by failure to realize the disturbing influence of variations in the physical state of the fat, and to devise a simple procedure for determining the specific gravity of milk under conditions which would permit no such variation.

METHOD USED TO DETERMINE THE SPECIFIC GRAVITY

The ordinary laboratory form of the Westphal balance does not have the sensitivity desired, and therefore a more sensitive one was constructed from an ordinary chainomatic weighing balance. A sinker of sealed glass tubing, having a displacement of approximately 25 cc. and weighted with sufficient mercury, was suspended from one arm of the balance. The sinker was suspended by a small platinum wire sealed into one end of the sinker. The portion of the wire which passed through the surface of the liquid was first rubbed with a small amount of oleic acid to decrease the influence of surface tension on the wire. The milk was contained in an insulated tall form beaker of 200 ml. capacity, which was supported over the pan of the balance. The milk was adjusted to the desired temperature with an accuracy of $\pm 0.1^\circ \text{C}$. The specific gravity could be determined with a reproducibility of 2 or 3 in the fifth decimal place. Care was taken to avoid: the presence of air bubbles in the milk; the uneven distribution of fat; and changes in temperature. The specific gravity was obtained by dividing the weight of milk displaced by the bulb, by the weight of air-free, distilled water displaced by the bulb, both displacements being determined at the same temperature.

The modified Westphal balance was used in this work because a simple, rapid method giving a high degree of accuracy was desired. If a high degree of accuracy is not desired, then a lactometer or hydrometer may be used. The accuracy of the results will depend upon the sensitivity of the lactometer. In any case the lactometer should be calibrated.

Effect of air bubbles

Errors arise if the specific gravity is determined too soon after milking, owing to the presence of small air bubbles. A sample of freshly drawn milk was brought at once to the laboratory, warmed to 45° , and cooled to 30°C . Its specific gravity was found to be 1.03335 at 30°C . After standing for 3 hours, the specific gravity was found to be 0.00007 higher. The air bubbles are relatively large, and they soon rise to the surface of the milk and rupture. This process can be hastened in the laboratory by placing the milk in an Erlenmeyer flask, placing the flask in a vacuum desiccator the bottom of which is covered with water, and applying a vacuum for a minute or two, at the same time causing the milk in the flask to swirl by rotating the desiccator.

*Effect of previous temperature treatment on the specific gravity
of milk at 15 and 30° C.*

Samples of whole milk, which varied in respect to breed, stage of lactation, fat and solids-not-fat content, were studied. The specific gravity of each sample was determined after it was subjected successively to the four treatments shown in Table 1. Care was taken to prevent evaporation during the treatment and handling of each sample.

TABLE 1

*Effect of warming and cooling on the specific gravity of whole milk at 15° C. (59° F.)
and 30° C. (86° F.). Average of 30 experiments*

	SPECIFIC GRAVITY
Held 24 hrs. at 2° C. Warmed to 15° C.	1.03236
Held $\frac{1}{2}$ min. at 45° C. Cooled to 15° C.	1.03134
Difference	0.00102
Held 24 hrs. at 2° C. Warmed to 30° C.	1.03008
Held $\frac{1}{2}$ min. at 45° C. Cooled to 30° C.	1.02998
Difference	0.00010

These data show clearly that appreciably different specific gravity values may be obtained for the same sample of milk, measured at 15° C., due to variations in the heat treatment of the milk before making the specific gravity determinations.

The variations are caused by the fat. This is shown by the fact that fat-free milk shows no such variation and by the fact that the variations in whole milk are linearly related to the fat content.

Fresh milk was held at 15° C. over night, cooled to 0° C. for an additional 24 hours, and then the specific gravity was determined after the following treatments: (1) warming to 15° C., (2) warming to 30° C., (3) warming to 45° C. and then cooling to 30° C., (4) cooling to 15° C. The differences between the specific gravity values obtained at each temperature are linearly related to the fat content of the samples as shown by Figure 1. The differences are more marked at 15° C. than at 30° C. The fact that a small difference was found at 30° C. indicates that warming to 30° C. was not sufficient to melt the fat completely.

In other experiments in which the milk was cooled to 2° C. without the preliminary holding at 15° C. the points were more widely scattered when plotted. This indicates a lack of uniformity in the solidification. Sharp and Rishoi (4) found that the rate of cooling had a marked effect on the specific heat of milk. Consequently the rate of cooling would be expected to have an effect on the specific gravity.

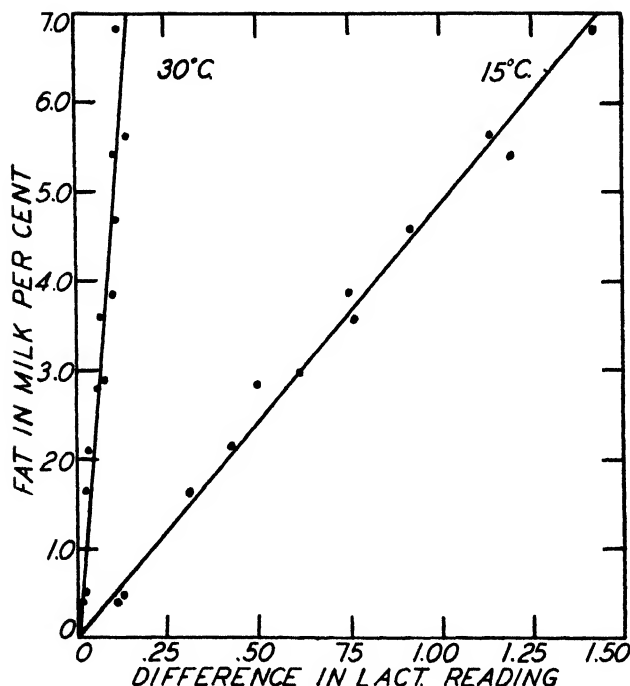


FIG. 1. RELATION BETWEEN FAT CONTENT OF THE MILK AND THE DIFFERENCE IN LACTOMETER READING AS INFLUENCED BY WARMING AND BY COOLING MILK TO 15° C. AND TO 30° C.

If the specific gravity is to be used in calculating the composition of the milk, the constants must be established and the specific gravity determinations must be made when the fat is in a definitely known and reproducible physical state. Almost of necessity the fat must be in the liquid state, because it is very difficult to obtain a definite degree of solidification.

Complete liquefaction can be accomplished by warming the milk to 45° C. (113° F.). Since this temperature is too high for convenience, it is recommended that the milk be cooled back to 30° C. (86° F.) for the determination of the specific gravity. At 30° C. no solidification or crystallization of the fat will occur, at least not until the milk has been held at this temperature for many hours.

It is apparent from a consideration of Table 1 and Figure 1 that deviations between the total solids of whole milk, as determined by drying and as calculated from the specific gravity determined at 15° C., may occasionally be as much as 0.5 per cent if the previous temperature history of the sample is diametrically opposite to that of the samples used in developing the equation. As examples, several equations which appear in the literature were tested and large deviations resulted.

Equations for calculating total solids from specific gravity determined at 30° C.

Equations for calculating the total solids from the fat content and the specific gravity of milk are of two forms: (1) those based on additive specific volumes which are correct for all specific gravities, and (2) those based on additive specific gravities which are correct only for the specific gravity at which the constants are determined.

The following is the type equation for additive specific gravities in which K_1 and K_2 are the constants:

$$\text{Total solids} = K_1 (\text{Fat content}) + K_2 (\text{Lactometer}) \quad (1)$$

Equation (1) is the simplest form of the equation, and the one used most often, because the calculations are simpler, and if the deviations from the specific gravity at which the constants were determined are small, only a negligible error is introduced. For every lactometer degree above that at which the constants were determined, 0.007 is subtracted from the calculated total solids, and for every degree below, 0.007 per cent is added to the calculated total solids.

The following is the equation of additive specific volumes:

$$\frac{100}{\text{Sp. gr. milk}} - \frac{\text{Fat}}{\text{Sp. gr. fat}} + \frac{\text{T.S.} - \text{Fat}}{\text{Sp. gr. s.n.f.}} + \frac{100 - \text{T.S.}}{1} \quad (2)$$

By simplification and grouping of constants, it can be changed into the following form for use:

$$\text{T.S. (Total Solids)} = K_3 \text{ Fat} + K_4 \left(100 - \frac{100}{\text{Sp. gr. milk}} \right) \quad (3)$$

The factor $\left(100 - \frac{100}{\text{Sp. gr. milk}} \right)$ converts the equation from additive specific gravities to additive specific volumes. This correction factor appears in the literature in the following forms which are equivalent:

$$10 \left(100 - \frac{100}{\text{Sp. gr. milk}} \right) \quad (4)$$

$$\left(1000 - \frac{1000}{\text{Sp. gr. milk}} \right) \quad (5)$$

$$\left(\frac{1000 \text{ Sp. gr.} - 1000}{\text{Sp. gr. milk}} \right) \quad (6)$$

$$\left(\frac{\text{Lactometer}}{1000 + \text{Lactometer}} \right) \quad (7)$$

$$\left(\frac{\text{Lactometer}}{\text{Sp. gr. milk}} \right) \quad (8)$$

The factor 10 of (4) is removed from the K_4 in equation (3).

The following is the simplest form of the equation for additive specific volumes:

$$\text{Total Solids} = K_3 \text{ Fat} + K_1 \left(\frac{\text{Lactometer}}{\text{Sp. gr. milk}} \right) \quad (9)$$

The total solids and fat content of 30 samples of milk from individual cows and 30 samples of gravity skimmed milk from the same samples were determined by the Mojonnier methods. The specific gravity of each of these 60 samples was also determined at 30° C., after warming to 45° C.

Three pairs of constants were calculated, by the method of least squares, for each of the equations (1) and (9). The constants calculated for the skimmilk alone gave appreciable errors when applied to whole milk, and constants calculated for whole milk gave slight but consistently lower values when applied to skimmilk. The most satisfactory pairs of constants were calculated from all of the data for both whole milk and skimmilk. They are substituted in the equations given below:

$$\text{Total solids} = 1.2648 \text{ Fat} + 0.2586 \text{ Lactometer} \quad (10)$$

$$\text{Total solids} = 1.2537 \text{ Fat} + 0.2680 \left(\frac{\text{Lactometer}}{\text{Sp. gr. milk}} \right) \quad (11)$$

The differences between the total solids as determined by drying, and as calculated from the fat content and the specific gravity, are given in Table 2. The samples included milk from the following breeds: Holstein, Jersey, Guernsey, Ayrshire, Brown Swiss, and Shorthorn. The composition of the milk ranged as follows:

	<i>Whole milk</i>	<i>Skimmilk</i>
Fat	3.07% to 6.77%	0.06% to 1.10%
Plasma Solids	8.33% to 9.56%	8.65% to 10.08%
Total Solids	11.66% to 15.85%	8.80% to 10.70%

The deviations in Table 2 are on the whole satisfactorily small. No relation between the deviations and the fat or plasma solids content was indicated when the data were plotted. Some of the deviations, especially in the whole milk series, columns 2 and 4, were larger than were expected. It is believed that the cause of the large deviations is to be found in the determination of the total solids by drying, and is not due to errors in the specific gravity method.

Errors in the determination of total solids by drying

The maximum errors involved in the various determinations, expressed in terms of total solids in the milk, were estimated to be as follows:

Fat, limit between duplicates	0.01%
Total Solids, limit between duplicates	0.05%
Specific Gravity, limit of variation	0.03%

If by chance all of these errors were to operate in one direction, the maximum deviation between the total solids as determined by the two methods

TABLE 2

Difference between the total solids as determined by drying and as calculated from the specific gravity determined after cooling to 30° C., and the fat content

COW NO.	EQUATION (10) ADDITIVE SP. GRAVITIES		EQUATION (11) ADDITIVE SP. VOLUMES		DIFFERENCE IN SOLIDS IN FAT FREE PLASMA CALCULATED FROM MILK AND SKIMMILK (5)	EQUATION (11) RECALCULATED T.S. OF WHOLE MILK USING	
	Skim- milk (1)	Whole milk (2)	Skim- milk (3)	Whole milk (4)		Skim plasma (6)	Average whole and skim plasma (7)
	%	%	%	%	%	%	%
1	-.04	-.04	-.04	-.04	+.02	-.04	-.05
2	-.08	+.11	-.05	+.12	-.14	-.05	-.04
3	-.20	+.14	-.21	-.14	-.03	+.07	.00
4	+.04	+.15	+.03	+.16	-.05	+.05	+.07
5	-.06	+.01	+.05	+.01	+.06	-.03	.00
6	-.06	-.05	-.06	-.05	-.01	-.06	-.07
7	-.02	+.07	.00	+.08	-.06	+.05	-.02
8	-.17	-.03	-.19	-.05	-.12	+.10	-.06
9	-.07	+.05	-.07	+.06	-.07	+.02	+.05
10	-.15	-.30	-.12	-.29	+.25	.00	-.12
11	-.03	-.02	-.02	+.03	-.04	+.02	.00
12	-.04	+.05	-.05	+.04	-.03	+.03	-.01
13	-.03	.00	-.03	-.02	+.05	+.01	+.08
14	-.01	+.13	-.01	-.12	-.03	+.13	+.15
15	+.02	-.10	+.01	-.21	+.25	-.07	-.04
16	-.05	-.16	-.04	-.16	+.10	-.01	-.06
17	.00	-.06	.00	-.05	-.13	-.11	+.04
18	+.01	-.04	.00	-.06	-.07	-.04	+.07
19	+.02	-.08	+.01	-.09	+.12	-.02	-.03
20	+.07	+.21	+.08	+.21	-.04	+.18	+.20
21	+.11	+.12	+.11	+.12	+.01	+.12	+.12
22	+.08	+.20	+.08	+.20	-.06	+.09	+.13
23	+.03	+.22	+.03	+.22	-.13	+.02	+.08
24	+.04	-.16	+.05	-.15	+.22	.00	-.11
25	-.08	-.07	-.05	-.07	+.04	-.10	-.12
26	-.12	-.02	-.13	-.03	-.08	+.09	-.06
27	+.09	+.10	+.10	+.11	+.05	+.15	+.12
28	+.15	+.19	+.15	+.19	.00	+.15	+.15
29	+.04	+.04	+.04	+.03	+.05	+.01	-.03
30	+.01	+.07	+.03	+.09	-.03	+.01	+.02
Mean error	-.017	+.024	-.010	+.001	+.001	+.026	+.015
Mean deviation	.064	.094	.061	.107	.081	.061	.070

would be 0.09 per cent. Several deviations are greater than this limit. The possible causes for these higher deviations were studied.

An error in the determination of the total solids in whole milk by drying was suspected because 14 samples of whole milk, column 4 of Table 2, showed deviations greater than 0.09 per cent, while only 7 samples of skimmilk exceeded this limit. This was shown to be the case by calculating the solids content of fat-free plasma, using in one case the whole milk analyses and in the other the skimmilk analysis. If no errors occurred in the determinations of fat and total solids, the results should be the same. The differences

between these two calculated values are shown in column 5 of Table 2. Although in every case the total solids as determined by drying represented the average of duplicates which did not deviate from each other by more than 0.05 per cent, yet errors as high as 0.25 per cent may have occurred in some of the determinations of dry matter of whole milk.

The deviations in column 4 plotted against column 5 of Table 2 showed a linear relationship. This indicates that the errors in the determination of the solids in whole milk by drying actually exceed the errors in the determination of the solids in whole milk by calculations from the specific gravity and the fat content. This was further shown by the fact that the deviations were decreased if the plasma solids as calculated from the skimmilk were substituted (by calculation) in the experimentally determined total solids of whole milk. Such a substitution (column 6) eliminated all but one of the large deviations in column 4. The substitution of the average of the solids in the plasma phase (column 7) of skimmilk and whole milk also reduced the deviations below those obtained by using the total solids as obtained by drying whole milk itself.

Insofar as small differences are concerned, the determination of dry matter in substances such as milk is essentially an arbitrary process, the actual values obtained depending on the technique employed. The results are affected by the condition of the sample, the accuracy of sampling, drainage of the pipette (even though the sample is weighed in the dish), time and temperature of drying, thickness of the layer in the dish, vapor tension of the air in the oven, and oxidation and decomposition of the organic material. Variations in drying technique may in some cases account for the lack of agreement between the total solids as determined by drying and as calculated from the specific gravity.

Effect of lactose

Variations in the amount of lactose should have little effect on the specific gravity of the plasma solids of milk, since lactose in solution has a specific gravity of about 1.63. This value is nearly the same as the specific gravity of the plasma solids which, according to our determinations, average 1.592 at 30° C. In order to make sure that lactose in milk exerted no untoward effect on the specific gravity, the specific gravity and total solids of a number of samples of milk were determined before and after the addition of 2 per cent of lactose. Calculations indicate that this addition should introduce a positive error of only 0.02 per cent. The results, expressed as the differences between the total solids as determined by drying, and by calculation from the specific gravity, are presented in Table 3. The total solids ranged from 8.91 to 14.07, and the fat from 0.09 to 5.30 per cent, in the samples examined. Variations in lactose content do not affect appreciably the reliability of the calculations of the total solids from the specific gravity.

TABLE 3

Effect of adding 2% of lactose to milk of various fat contents, on the deviation between the total solids as determined by drying and as calculated from the specific gravity

SAMPLE NUMBER	DEVIATION		EFFECT OF LACTOSE
	Before adding lactose	After adding lactose	
	%	%	%
1	-.02	0.00	+.02
2	-.07	-.06	+.01
3	-.02	-.11	-.09
4	-.07	+.04	+.11
5	+.01	+.04	+.03
6	+.02	+.04	+.02
7	+.05	-.02	-.07
8	+.09	+.10	+.01
9	+.12	+.01	-.11
10	+.04	+.03	-.01

Effect of citric acid

Most of the values for the amount of lactose present in milk are obtained by subtracting from the total solids of milk, the sum of the fat, protein and ash. The amount of lactose, therefore, may occasionally be in error in either direction, to the extent of the sum of all the errors in the above four determinations. In addition, such a method for determining lactose is in error to the extent of the amount of citric acid present in milk. By the above method the citric acid is calculated as lactose. The amount of citric acid present in milk is variously given as from 0.2 to 0.3 per cent. Citric acid in solution has a specific gravity of 1.68 at 30° C. Since the amount of citric acid present is small, and its specific gravity is near that of the plasma solids of milk (1.59), variations in citric acid content will not appreciably affect the reliability of the calculation of the total solids of milk from the specific gravity and the fat content.

Ratio of protein to ash content

The amount of protein and ash in milk, or more particularly their ratios, tend to introduce the greatest error in determining the total solids in milk from its specific gravity and fat content. The proteins have a specific gravity of about 1.35, while our data indicate a specific gravity of 5.5 for the ash constituents.

The ratio of protein to ash is usually slightly greater than 5.0. This ratio is obtained in milk with 3.5 per cent of protein and 0.70 per cent of ash, which in terms of solids corresponds to a specific gravity in milk of 1.54. If the ash is calculated to drop to 0.6, the ratio becomes 5.8 and the specific gravity values for total solids are calculated to be 0.12 per cent too low. If the ash is 0.8 the ratio becomes 4.4, and the calculated values are 0.12 per

cent too high. Actual experiments indicate that the addition of 0.10 per cent of sodium chloride renders the calculated values about 0.08 per cent too high.

The average ash content and the ratio of protein to ash of the milk from the various breeds, as obtained from the compilation of Overman, Sanmann and Wright (1) are as follows: Holstein, ash 0.681 per cent, ratio 5.0; Ayrshire, ash 0.683 per cent, ratio 5.2; Guernsey, ash 0.742 per cent, ratio 5.4; Jersey, ash 0.702 per cent, ratio 5.5; Holstein-Guernsey cross, ash 0.727 per cent, ratio 5.2; average for all breeds, ash 0.716 per cent, ratio 5.3. In the case of a few isolated samples, rather extreme ratios are reported.

Errors due to variation in protein and ash content are perhaps not so serious as one might expect, since protein and ash constituents increase together linearly with a coefficient of correlation of $0.622 \pm .009$, as shown by Overman, Sanmann and Wright.

Usually high ash milk is due to an abnormal amount of sodium chloride, which has a specific gravity in solution of 2.9, and not 5.5. A slight compensating factor present in milk samples of high sodium chloride content is the lower lactose, calcium and phosphate content. Furthermore, the milk samples with a low protein ash ratio usually contain small absolute amounts of these two constituents.

It is impossible to estimate from analytical data the error that one might expect as a result of variations in composition. In mixed milk the error probably would amount to only a few hundredths of a per cent of total solids. In the case of abnormal milk from a single cow it might be higher.

Equation applied to 421 samples

All of the comparisons made between the total solids as calculated from the specific gravity of the milk determined after cooling to 30° C., and by actual drying, have been grouped and are presented in Table 4. This table includes 287 samples of bottled market milk collected at two different seasons of the year from various cities in New York State. The remaining samples were obtained from different individual cows or are samples in which the effects of variations in fat, lactose and plasma solids were studied. Since our previous discussion has indicated that the errors in the total solids calculated from the specific gravity are at least as small as the errors obtained in determining the total solids by drying, the deviations in Table 4 can be attributed no more to errors in the determination of the total solids from the specific gravity, than to the errors in determining the total solids by actual drying of the samples.

The deviations were plotted in one case against the fat content of the samples and in the other case against the plasma solids content of the samples, but no relation was found between these components and the deviations.

In the case of the 287 samples of commercial milk, the fat as determined by the Babcock method was used in the equation for calculating the total solids from the specific gravity, the fat being expressed to the nearest 0.1 per cent.

TABLE 4

Differences between the total solids as determined by drying by the Mojonnier method and as calculated from the specific gravity and fat content. 421 samples

DEVIATIONS NOT GREATER THAN	NUMBER OF SAMPLES	PERCENTAGE OF TOTAL NUMBER
%		%
0.05	124	29.5
0.10	91	51.1
0.15	94	73.4
0.20	58	87.2
0.25	50	99.1
0.30	4	100.0
Mean error		-.011
Mean deviation		.094

The specific gravity of the milk constituents at 30° C.

The specific gravities of the plasma solids and the fat as they occur in milk were calculated by the method of least squares, from the analysis of 30 samples of whole and 30 samples of skimmed milk, by substituting the experimental values in the following equation, which expresses the relation between the variables in terms of specific volumes:

$$\frac{100}{\text{Sp. gr. milk}} = \frac{\text{Fat}}{\text{Sp. gr. fat}} + \frac{\text{Plasma solids}}{\text{Sp. gr. plasma solids}} + \frac{\text{water}}{1}$$

The results obtained are given below:

	Fat	Plasma solids
30 samples of whole milk	0.9140	1.5900
30 samples of gravity skim milk	0.8915	1.5941
60 samples of whole and skimmilk together	0.9121	1.5930

These data indicate that fat has a specific gravity of 0.913 and the plasma solids a specific gravity of 1.592 as they exist in milk when cooled to and measured at 30° C.

Substituting the known specific volumes in a suitable equation involving the different constituents of milk, the specific gravity of the ash was calculated to be 5.5. The specific gravity of the ash constituents as estimated from the specific gravity of pure inorganic salts in solution was 3.3.

The specific gravity of the milk constituents at 30° C. as we have determined them are given in Table 5 in comparison with those given by Richmond (3).

TABLE 5
Specific gravity of the milk constituents

	SHARP AND HART AT 30° C.	RICHMOND AT 15° C.
Fat	0.913	0.93
Plasma solids	1.592	1.616
Lactose	1.63	1.666
Citric acid	1.68	(as lactose)
Protein	1.35	1.346
Ash	5.5	5.5

CONCLUSION

1. The previous temperature history of the milk influences its specific gravity at 15° C. This effect is due to variations in the physical state of the fat. The magnitude of the effect increases with the fat content.

2. The determination of the specific gravity at 30° C. after previous warming to 45° C. for one-half minute is recommended as a method which will insure that the determination is made while the fat is in the liquid state.

3. The following equation then applies for calculating the total solids from the fat content and the specific gravity:

$$\text{Total Solids} = 1.2537 \text{ Fat} + 0.2680 \frac{\text{Lactometer}}{\text{Sp. gr. of milk}}$$

4. In 421 comparisons of the total solids as calculated by the above equation and as determined by drying, the deviation between the two values never exceeded 0.30 per cent.

5. The possibility of errors in the determination of total solids by drying is pointed out.

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AN EXPERIMENT IN CHOPPING ALFALFA HAY AT THE TIME OF STORAGE

EFFECT UPON SPACE REQUIRED, TEMPERATURES ATTAINED, COLOR,
FEEDING VALUE, AND LOSSES OF FEED CONSTITUENTS

T. E. WOODWARD AND J. B. SHEPHERD

Bureau of Dairy Industry, U. S. Department of Agriculture, Washington, D. C.

Interest in chopping hay when it is hauled from the field to be put in the mow has been stimulated recently by certain manufacturers of farm buildings and farm machinery. Farmers will want to decide sooner or later whether to chop or not to chop their hay. If a farmer is raising hay to sell or if he is making only a small quantity and does not have access to the necessary machinery, it won't be hard for him to decide not to chop his hay. On the other hand, if he is making considerable hay for his own livestock and if he has the necessary machinery, he can well afford to give serious consideration to the matter of chopping.

The principal advantages which have been claimed for chopping are that more hay can be put in a given space, the job of making hay is easier, and there is less waste in feeding. The chief disadvantages are more dust in the barn, and more care required in curing. In view of the interest that is being taken in the chopping of hay for dairy cattle and other livestock, an experiment was made to get some exact information on the value of chopping hay, although the claims presented do not appear unreasonable.

A hay barn at the National Agricultural Research Center at Beltsville, Md., was partitioned off into four compartments. Two of these to be used for chopped hay had a floor space of approximately 8 by 12 feet each; the other two to be used for long hay had a floor space of approximately 12 by 20 feet each.

First-cutting alfalfa was used. Part of the hay was mowed June 11, raked June 12, rained on the night of June 12, turned June 13, and put in the mow June 14. There was some dew on the first two or three loads. The first compartment was filled with hay run through the cutter and blown into the mow. The knives of the cutter were set for cutting $\frac{1}{4}$ inch lengths. Alternate loads, as hauled from the field, were stored in another compartment in the natural long form. Five loads weighing about 6 tons in all were stored in each of these compartments. This quantity made the depth of hay 9 feet in each compartment.

Three days later the other two compartments were filled. The hay was mowed June 16, raked the same day, and put in the mow June 17 after the dew was off. The knives of the cutter were set to cut $\frac{3}{4}$ inch lengths, instead of $\frac{1}{4}$ inch lengths, as was done in chopping hay of the first lot mowed. Four

loads, or about 5 tons, were chopped, and about the same quantity was stored in long form.

When each of the four compartments was being filled, samples of the hay placed in it were taken for chemical analysis.¹ Part of each sample was used to determine the composition of the hay at time of storage, and a similar portion was placed in a burlap bag. The bags of hay were buried at different depths in a vertical row in the center of the compartment. Those of the chopped hay were placed between each two loads, and those of the long hay were placed in the middle of each load. They were recovered three to five months later as the hay was removed from storage, and were analyzed to show the change in composition.

In each compartment a half-inch galvanized pipe was inserted at the center so that the lower end was at about the top of the first load put in. Temperatures were taken by lowering ordinary mercury thermometers into these pipes.

The hay used in the two lots was cured to about the same extent when put in storage, but none of it was quite as dry as most farmers would like to have their hay to put in the mow or stack. The finely chopped hay of the first lot had 27.02 per cent moisture and the long hay stored for comparison had 27.42 per cent. The coarsely chopped hay and the long hay of the second lot both had 25.31 per cent moisture.

METHOD OF FEEDING

Feeding of the first lot started after the hay had been in storage about 100 days. Chopped hay and long hay were fed concurrently to the two groups of Holstein cows by the single reversal method. The finely chopped hay and long hay of the first lot were fed to 8 cows, 4 in each group. Concentrates were fed liberally until the cows became accustomed to chopped hay and then in amounts judged sufficient to maintain their body weights without material gain in weight. These cows were on the experimental ration 7 days before the first 30-day feeding period began. After 30 days the two groups were reversed and the feeding continued for another 30 days.

Then the coarsely chopped hay and long hay of the second lot were fed by the same method to two groups of 3 cows each. The 7-day preliminary period was omitted because most of these cows were already accustomed to eating chopped hay.

RESULTS

Time required to store hay by each of the two methods

When the hay was chopped in $\frac{1}{4}$ inch lengths and blown into the mow, three men stored the hay at the rate of 1 ton in 14 minutes; when it was pitched into the mow by hand and stored in long form, three men required

¹ All the chemical analyses were made by C. G. Melin, Bureau of Dairy Industry.

19 minutes to unload a ton. The time required to unload a ton of long hay by using a horse-drawn hay fork or a power-driven hoist was not determined.

The mow space occupied

The mow space occupied by the hay at time of storage and when it was taken out is shown in Table 1. All the hays lost considerable weight in storage through drying out. The chopped hay settled very little. This explains why a ton of the dry chopped hay occupied more space at the time of removal than a ton of the freshly chopped hay did at the time of storage. Because of settling and a higher dry matter content, both the long and chopped hays contained more dry matter per cubic foot of storage space occupied when they were taken out than they did at the time of storage.

At the time of storage a ton of finely chopped hay occupied only 32 per cent, and a ton of coarsely chopped hay, 46 per cent, as much storage space as a ton of long hay. When taken out, a ton of the dry finely chopped hay occupied 40 per cent, and a ton of the dry coarsely chopped hay, 56 per cent, as much storage space as a ton of the dry long hay.

TABLE 1

Mow space occupied by chopped hay and long hay when put in storage and when taken out

	QUANTITY OF HAY	STORAGE SPACE PER TON	DRY MATTER		
			Per cent	Per ton	Per cubic foot
	<i>Tons</i>	<i>Cubic feet</i>		<i>Pounds</i>	<i>Pounds</i>
First lot of hay					
Finely chopped hay:					
Hay put in storage	6.09	152	72.98	1459.6	9.60
Hay removed from storage	4.62	164	89.90	1798.0	10.96
Long hay:					
Hay put in storage	5.90	475	72.58	1451.6	3.06
Hay removed from storage	4.54	412	90.55	1811.0	4.40
Second lot of hay					
Coarsely chopped hay:					
Hay put in storage	5.02	218	74.69	1493.8	6.85
Hay removed from storage	3.94	229	92.07	1841.4	8.04
Long hay:					
Hay put in storage	5.16	475	74.69	1493.8	3.14
Hay removed from storage	4.06	412	91.52	1830.4	4.44

The maximum temperature attained

The finely chopped hay reached a high temperature of 151° F. in 9 days and after 3 months the temperature was still about 100° F. Some spots developed a maximum temperature of 190° F. The coarsely chopped hay

reached a maximum temperature of 128° F. in 19 days, and in 2 months the temperature had decreased to that of the air. The long hay of the first lot reached a temperature of 122° F. in 4 days, and that of the second lot 120° F. in 1 day. In 3 weeks the temperature of both was down to about that of the air.

*The influence of the method of storage upon
the carotene content*

When the first lot of hay was stored in the mow, the finely chopped hay and the long hay each had a carotene content of 46 parts per million on a dry-matter basis; when the hay was removed, the carotene content of the finely chopped hay was only 0.9 part per million of dry matter, or practically nothing; and that of the long hay was 2.9, which was a little better but still very low. The coarsely chopped hay and the long hay of the second lot each showed a carotene content of 74 parts per million of dry matter at the time of storage. When these hays were removed, the carotene content of the coarsely chopped hay was 3.8, and that of the long hay was 4.9.

The effect upon the color²

When removed from storage, the finely chopped hay varied in color from brown to black; the coarsely chopped hay was a lighter brown, but in neither lot of chopped hay was there any green color whatever. The long hay of the first lot had from 1 to 25 per cent as much green color as the greenest grade of alfalfa hay, and the long hay of the second lot had from 14 to 45 per cent as much. The latter hay, however, had more green color at the time of storage than the long hay of the first lot because it had cured in the field more quickly and had not been wet with rain. The color of the long hay in the first lot was best at the center of the compartment, and the color of the second lot was best near the top.

Influence on the losses of weight and of dry matter

The weights of the different lots of hays and of the dry matter the hays contained at the time they were stored, the weights at the time of removal from storage, and the losses in weight and dry matter during storage are shown in Table 2. The finely chopped hay lost 6.5 per cent dry matter, the coarsely chopped hay 3.2 per cent, and the long hays of the first and second lots 4.1 and 3.5 per cent, respectively. In view of the high temperatures attained by the finely chopped hay and the length of time the high temperatures persisted, the 6.5 per cent loss of dry matter appears very moderate.

² Color determinations were made by Carl F. Welsh, Bureau of Agricultural Economics.

TABLE 2

Weights of hay and dry matter put in storage, the weights taken out, and the losses in weights and dry matter

		FIRST LOT OF HAY		SECOND LOT OF HAY	
		Finely chopped hay	Long hay	Coarsely chopped hay	Long hay
Weight of hay stored	pounds	12,175	11,810	10,040	10,315
Weight of hay when removed	pounds	9,245	9,078	7,882	8,125
Loss in weight during storage	pounds	2,930	2,732	2,158	2,190
Loss in weight during storage	per cent	24.1	23.1	21.5	21.2
Moisture content of hay stored	per cent	27.02	27.42	25.31	25.31
Moisture content of hay removed	per cent	10.10	9.45	7.93	8.48
Dry matter in the hay stored	pounds	8,885	8,572	7,499	7,704
Dry matter in the hay removed	pounds	8,311	8,220	7,257	7,436
Loss of dry matter	pounds	574	352	242	268
Loss of dry matter	per cent	6.5	4.1	3.2	3.5

The analyses were applied to the weights given in Table 1 and it was found that by far the greatest part of the dry matter loss was in the nitrogen-free extract. There appeared to be no loss of either protein or fiber, and no great loss of ether extract. The data presented do not, of course, include the losses that occurred between the time of mowing and storing.

The effect upon the feeding value

Palatability.—The cows at first were reluctant to eat the black finely chopped hay. In order to induce them to eat more of the black chopped hay, concentrates were mixed with the chopped hay and equivalent amounts given the group on long hay. This explains why such liberal quantities of concentrates were fed in the first 30-day period of the experiment. After the cows became accustomed to the black hay, they ate as much of it as the other group ate of the long hay. The hay that was brown instead of black was generally consumed in slightly larger amounts than was the long hay. This was the case whether the hay was finely chopped or coarsely chopped.

Quantities of hay eaten.—Enough hay was fed each cow every day so that there was nearly always a small amount refused. The highest quantity refused by a group in any 30-day period was 10 per cent, and the lowest was 7 per cent. Feeding the hay in this way made it impossible to estimate the quantity which would have been wasted if the cows had been fed equal quantities. The smallest average quantity of hay consumed per cow per day by any group for a 30-day period was 26.4 pounds, and this was by group No. 1, fed finely chopped black hay in the first period; the highest was 34.2 pounds by group No. 3, fed coarsely chopped hay in the first period on that lot of hay.

Production.—The total quantity of milk and quantity of butterfat produced was a little more when the cows were fed the long hay. This was the

TABLE 3
Summary of feed eaten, production of milk and butterfat, and body weights

	TOTAL FEEDS EATEN BY GROUP			TOTAL PRODUCTION OF GROUP			DECLINE IN MILK PRODUC- TION	BODY WEIGHT	
	Concen- trates	Hay	Total digestible nutrients	Milk	Butter- fat	Average per cow		Gain or loss per cow	
	Pounds	Pounds	Pounds	Pounds	Pounds	Per cent	Pounds	Pounds	
First lot of hay									
Finely chopped hay:									
First 30-day period (Group 1)	1,374	3,166	2,667	3,258.0	102.83	22.6	1,163	+104	
Second 30-day period (Group 2)	571	4,036	2,466	3,159.8	102.90	24.3	1,255	-4	
Total	1,945	7,202	5,133	6,417.8	205.73	23.4		+150	
Long hay:									
First 30-day period (Group 2)	1,354	3,327	2,658	3,909.7	122.92	+0.1	1,215	+107	
Second 30-day period (Group 1)	376	3,822	2,204	2,718.2	86.37	18.0	1,176	-11	
Total	1,730	7,149	4,862	6,627.9	209.29	18.9		+148	
Second lot of hay									
Coarsely chopped hay:									
First 30-day period (Group 3)	283	3,076	1,830	2,243.5	75.66	10.8	1,285	+38	
Second 30-day period (Group 4)	239	2,644	1,556	2,101.4	71.31	119.3	*1,223	(**)	
Total	522	5,720	3,386	4,344.9	146.97	115.0			
Long hay:									
First 30-day period (Group 4)	336	2,811	1,703	2,470.4	81.27	+1.1	1,231	+37	
Second 30-day period (Group 3)	184	2,809	1,593	1,988.7	65.98	18.4	*1,268	(**)	
Total	520	5,620	3,296	4,459.1	147.25	18.6			

1 Average for 30-day period.

* Estimated.

** Final weights were not taken because three of the six cows in Groups 3 and 4 were in quarantine.

case whether finely chopped or coarsely chopped hay was fed in comparison with the long hay. Although Table 3 shows that the difference in the total production of the cows when fed chopped hay and long hay was rather small, there is no doubt that if the continuous instead of the reversal method had been used in conducting this experiment, the differences would have been somewhat greater and more favorable to the long hay. Moreover, in this connection it should be observed that when the cows were fed the long hay they consumed less digestible nutrients than when they were fed the chopped hay.

The average rate of decline in milk production of the four groups by 30-day periods is shown in Table 3. The percentage decline was calculated from the first 3 days and the last 3 days of each 30-day period. The decline

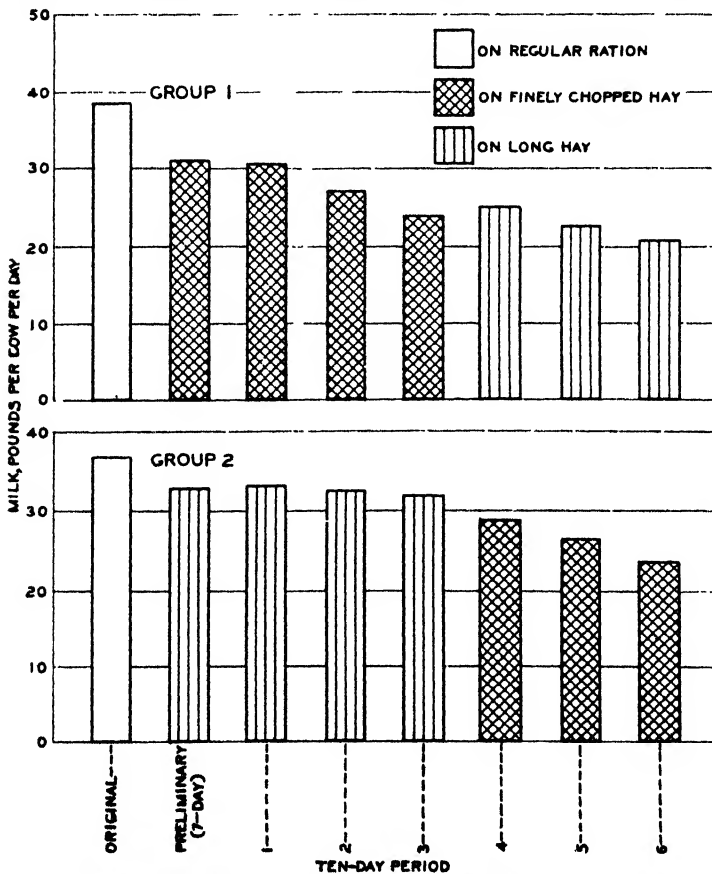


CHART 1. Average milk production by 10-day periods on finely chopped hay and long hay of the first lot.

for the periods when long hay was fed are not far from normal, being 8.9 per cent for the first lot of hay and 8.6 per cent for the second lot of hay during the two 30-day periods on each hay. When the finely chopped hay was fed, the average decline in milk production for the two 30-day periods was 23.4 per cent and that of the cows on coarsely chopped hay was 15.0 per cent.

Chart 1 shows the declines in milk production per cow per day for the two groups on finely chopped hay and long hay of the first lot, by 10-day periods, beginning with the 10 days on the regular ration before the experiment started. The chopped hay fed at first was very dark in color. Both groups declined sharply in milk production during a 7-day preliminary period, but the yield of the cows fed the finely chopped hay fell off more than that of the cows on long hay. Thereafter the production of both groups was sustained better than at first. This chart shows that when the cows

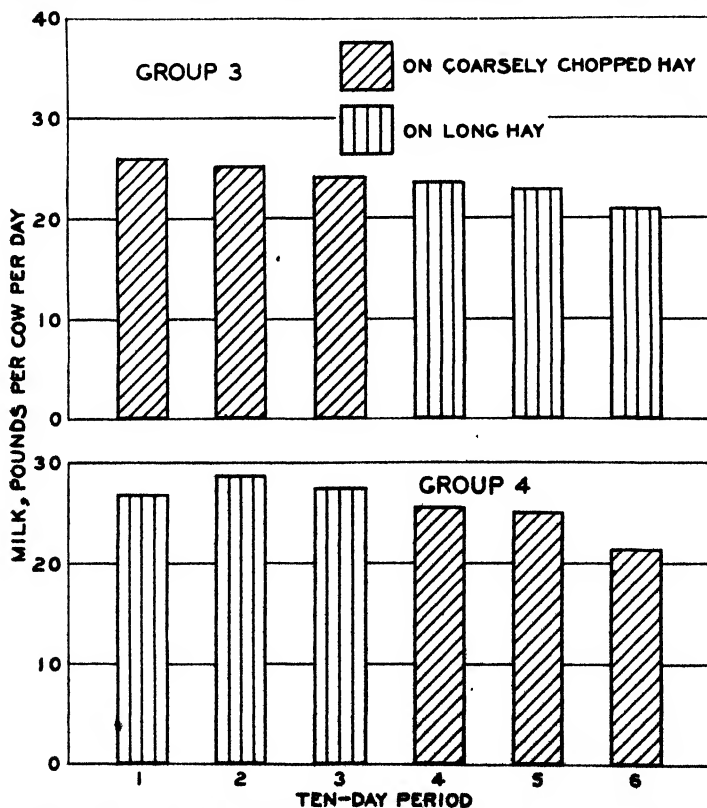


CHART 2. Average milk production on coarsely chopped hay and long hay of the second lot.

were on long hay they maintained their production better than when fed the finely chopped hay. Chart 2 gives a similar comparison for the two groups fed coarsely chopped and long hay of the second lot. The coarsely chopped hay maintained production better than the finely chopped hay, but was not as good for milk production as the long hay.

The difference in milk production for the last 10 days previous to a change in hay feeding as compared with the first 10-day period after the change, as shown in Charts 1 and 2, also favors the long hay. When the kind of hay fed was changed at the end of the first 30-day period from finely chopped to long hay, the average daily milk production per cow increased from 23.9 pounds to 24.9 pounds. When the change was made from the long hay to the finely chopped hay, the milk declined from 32.0 pounds to 28.9 pounds. Similar figures for the second part of the experiment, in which coarsely chopped and long hay were compared, did not show such pronounced differences, although the advantage was still with the long hay. When feeding was changed from the coarsely chopped hay to long hay, the milk yield per day per cow declined from 23.9 to 23.2 pounds, and when it was changed from long to coarsely chopped hay, the yield declined from 27.5 to 25.4 pounds.

Body weights.—During the 7-day preliminary period after groups 1 and 2 were taken off the original ration, all of the cows in both these groups lost weight, with the result that they were somewhat gaunt when the experiment proper started. This will explain the large gains made in body weight (Table 3) during the first 30-day period by both of these groups. The final weights of groups 3 and 4 on coarsely chopped and long hay were not taken, because 3 of the 6 cows were quarantined during the last week of the experiment. The other weights given show that both groups gained or lost at about the same rate, indicating that the level of feeding was much the same for the groups being compared.

SUMMARY

Running the hay through a cutter and blowing it into the mow was easier than storing it in a long condition, mainly because the hand work in the mow was saved.

Two or three times as much hay could be put in a given space in the chopped form as in the natural long form.

The chopped hay heated more than the long hay, and the finely chopped hay heated more than the coarsely chopped hay.

Neither the carotene nor the green color was so well preserved in the chopped hay as in the long hay.

The loss of dry matter during storage was higher in the finely chopped hay than in the coarsely chopped hay or in the long hay, but the greatest loss observed in this experiment was still quite moderate.

The black chopped hay was not so palatable as the long hay, but the brown chopped hay was fully as palatable as the long hay.

The quantities of milk produced and the maintenance of the milk flow were in favor of the cows fed the long hay, and this was the case in spite of their slightly lower consumption of nutrients as estimated from actual analyses and the coefficients of digestion given by Henry and Morrison.

This investigation was with hay containing 25 to 27 per cent of moisture at time of storage, or a little higher than is usually considered desirable. The results with hay containing more moisture or less moisture might be somewhat different from those reported.

A COMPARISON OF PRESSURE AND CENTRIFUGAL HOMOGENIZATION OF ICE CREAM MIXES

J. C. HENING

New York Agricultural Experiment Station, Geneva, N. Y.

The improvement in body, texture, and quality of ice cream prepared from pressure homogenized ice cream mixes as compared to unhomogenized mixes is universally recognized. However, there appears to be no data in the literature comparing physical properties of ice cream mixes, and the quality of the ice cream prepared from them, when the mixes are homogenized with pressure and with centrifugal homogenization. The desirability of such experimental data seemed to warrant a study of this problem.

EXPERIMENTAL

Ice cream mixes for these experiments, with the exception of two later tests, were standardized to contain 12 per cent fat, 10 per cent milk-solids-not-fat and 14 per cent sugar. Cream, skimmilk and skimmilk powder were the dairy products used in preparing these mixes. They were pasteurized at 68.0° to 71.0° C. (155° to 160° F.) for $\frac{1}{2}$ hour and in some tests at 150° F. and homogenized and run through the centrifugal colloidal mill at pasteurization temperatures. A Manton-Gaulin homogenizer of 60 gallons per hour capacity with the two-stage valve was used for pressure homogenization of the mixes. A colloidal¹ mill of 100 gallons per hour capacity was used for the centrifugal homogenization of the mixes. After some preliminary trials with varying clearances of the metal surfaces of the mill the smallest possible clearance of 0.002 of an inch was used for all of the experiments. The 3-inch rotor of the mill revolved at 1700 R.P.M. The mixes were cooled over a surface tabular cooler to 4.4° C. (40° F.)

The viscosity determinations were made with the MacMichael viscometer using the disc bob. The viscosity was measured at 4.4° C. (40° F.). No endeavor was made to secure separate values for plasticity and viscosity.

In the first 3 experiments a motor driven stirrer as described by Whitaker (3) was used to thoroughly agitate the mixes to secure basic viscosity. The mixes were agitated for twenty minutes with the stirrer made of one-fourth inch wire screening, revolving at 500 to 600 revolutions per minute.

The fat globules were measured at a magnification of approximately 2000 diameters using an ocular micrometer disc standardized with the microscope so adjusted that each of the smallest marks represented one

¹ The colloidal mill was loaned to us by the Premier Mill Corporation of Geneva, New York.

Approved by the Director of the New York Agricultural Experiment Station as Journal Paper No. 164, June 15, 1936.

TABLE 1
Viscosity in centipoises and size of fat globules and fat globule clumps of pressure and centrifugal homogenized ice cream mixes

TREAT- MENT	AGING PERIOD											AV. SIZE OF FAT GLOBULE CLUMPS	NO. OF CLUMPS	AV. SIZE OF FAT GLOBULE CLUMPS				
	3/4 hr.		2 hrs.		4 hrs.		8 hrs.		24 hrs.		48 hrs.							
	Not agglu- tated	Agglu- tated	Not agglu- tated	Agglu- tated	Not agglu- tated	Agglu- tated	Not agglu- tated	Agglu- tated	Not agglu- tated	Agglu- tated	Not agglu- tated				Agglu- tated			
	cp.	cp.	cp.	cp.	cp.	cp.	cp.	cp.	cp.	cp.	cp.	cp.	cp.	microns		microns		
					Experiment 1—2000-500 pounds pressure													
H	16.8	15.8			16.5	16.5	16.2	15.8	16.5	15.8				1.61	43	1.58 × .79		
C	14.5	14.5			13.8	15.0	15.0	13.0	15.4	14.2				2.06	0			
Hg	33.5	41.0			88.0	123.8	179.8	55.3	235.8	54.2								
Cg	33.9	37.5			82.0	119.0	170.0	50.0	192.0	48.3								
					Experiment 2—1200-400 pounds pressure													
Hg	30.5	33.8	89.7	40.5			228.1	64.5	289.0					1.65	36	2.36 × 1.08		
Cg	33.8	30.0	87.0	44.0			218.0	53.5	243.0					2.10	0			
														1.74*	0			
					Experiment 3—900-300 pounds pressure													
H	14.5		15.0		16.5		15.0	14.9	15.0					1.96	23	2.26 × 1.13		
C	13.4		13.8		15.0		13.8	13.0	13.4					1.89*	0			
Hg	36.8		102.3	46.2	189.0		346.0	56.0	328.7									
Cg	34.2		103.5	41.0	165.3		282.0	55.0	296.4									

H = pressure homogenization with homogenizer without gelatin.

C = centrifugal homogenization with colloidal mill without gelatin.

Hg = same as H plus gelatin.

Cg = same as C plus gelatin.

* = run through colloidal mill 3 times.

micron. One-half cubic centimeter of the mix to be examined was diluted with 100 cc. of distilled water and mounted as a hanging drop preparation. Two hundred fat globules and the clumps found in the fields were measured for each mix processed except for some of the last experiments in which the clumps predominated and two hundred clumps were measured.

RESULTS

In the first series of experiments various two-stage homogenization pressures were used and an endeavor was made to determine what homogenization pressure would produce mixes and the ice cream prepared from them of similar properties to centrifugal homogenized mixes and ice cream. The results of the first experiments on three different mixes comparing their properties when processed by pressure and centrifugal homogenization, with a colloidal mill, are given in Table 1. The homogenization pressures for Experiments 1, 2 and 3 are 2000, 1200 and 900 pounds on the first stage and 500, 400, and 300 on the second stage, respectively.

As can be seen from this table, the ice cream mixes processed with the two-stage homogenizer were only a trifle more viscous than the centrifugal colloidal mill mixes. These mixes without gelatin were low in viscosity and showed no consistent increase in viscosity at aging periods of $\frac{1}{3}$ of an hour, 2, 4, 8, 24 and 48 hours. Agitation of these mixes prior to viscosity determinations had no appreciable effect on their viscosity. A little heat sometimes generated from friction in the agitation unit, caused a slight increase in the temperature of the mixes, which might account for slight decreases in their viscosity. Similar results were previously obtained by the author (2) when single-stage homogenized ice cream mixes were rehomogenized several times at 200 pounds pressure. Agitation did not reduce the viscosity of these mixes.

The mixes containing gelatin increased in viscosity throughout the 48-hour aging period. Agitation, as can be seen in Table 1, greatly decreased the viscosity of aged mixes due to the breaking up of the gel formation. When mixes in Experiment 1, containing gelatin, were agitated after 2 to 5 hours aging, they were practically as viscous in 24 hours as the same mixes which had not been agitated. However, when the homogenized and colloidal mill mixes containing gelatin in Experiment 1 were agitated after 48 hours aging their viscosity as shown in Table 1 was reduced to 54.2 and 48.3 centipoises, respectively, and after 24 hours these agitated mixes increased to 107.8 and 89.0 centipoises, which was about half the viscosity of the unagitated 48-hour aged mix.

In these first trials, given in Table 1, an endeavor was made to homogenize the mixes so that the fat globules in the pressure homogenized mixes would be approximately the same size as the fat globules in the centrifugal homogenized mixes. In Experiment 1 the fat globules of the pressure homogenized mixes were smaller than those of the centrifugal homogenized

mixes. In Experiments 2 and 3, in which the homogenization pressures were reduced to 1200 and 900 on the first stage and 400 and 300 on the second stage and the mix put through the colloidal mill 3 times, the fat globules of the pressure and centrifugal homogenized mixes averaged approximately the same size.

There was no clumping of the fat globules when the mixes were homogenized in the colloidal mill. The fat globule clumps in the pressure homogenized mixes increased in size and decreased in number as the pressures were reduced as can be seen from Experiments 1, 2 and 3, Table 1.

These mixes containing 0.5 per cent of a medium grade gelatin were frozen in a Miller 40-quart horizontal brine freezer. The mix in Experiment 1 (Table 1) homogenized with 2000 pounds pressure on the first stage and 500 on the second stage froze and whipped in about one minute less time than the centrifugal mix. The mixes in Experiments 2 and 3 homogenized at lower pressures froze and whipped in exactly the same time as the colloidal mill mixes. In Experiment 1 the ice cream from the pressure homogenized mix was a trifle smoother and firmer in body than the ice cream from the centrifugal homogenized mix. In Experiments 2 and 3 with lower homogenization pressures the ice creams prepared from mixes processed by the two methods were practically the same in body and texture and they were all a little coarse.

The ice creams prepared from the mixes homogenized in the centrifugal colloidal mill did not melt down as well as the ice creams prepared from pressure homogenized mixes due to churned fat particles forming a little framework which prevented a complete melting down of the ice cream.

The experiment reported in Table 1 was repeated comparing the same homogenization pressures of 2000-500, 1200-400, and 900-300 and centrifugal homogenization on a single mix in place of 3 different mixes. The results of this test are not given in table form since they were for all practical purposes the same as in the three preceding experiments.

The results of these first experiments indicated the desirability of comparing the properties of mixes processed with a series of two-stage homogenization pressures, with centrifugal homogenization and no homogenization. Ice cream mixes were homogenized with pressures on the first stage ranging from 4000 to 1000 pounds, decreasing at 500 pound intervals, with a constant pressure of 500 pounds on the second stage, and with 500 pounds on the first stage, with no pressure on the second stage, and with the centrifugal colloidal mill. These mixes were prepared and frozen without gelatin in order to limit the effects to pressure and centrifugal homogenization.

The results given in Table 2 are the average of results obtained for three mixes of the same composition prepared and processed at successive intervals. Each ice cream mix was subjected to the complete series of pressures and centrifugal homogenization. As in previous results there

TABLE 2

Viscosity in centipoises and size of fat globules and fat globule clumps of pressure and centrifugal homogenized ice cream mixes prepared without gelatin

PRESSURE	AGING PERIOD				AV SIZE OF FAT GLOBULES	NO OF CLUMPS	AV SIZE OF CLUMPS
	2 hrs	4 hrs	24 hrs	48 hrs			
	cp.	cp.	cp.	cp.	microns		microns
4000-500	22.0	21.6	21.8	21.6	9.3	109	1.63 × .84
3000-500	20.2	19.8	20.6	20.8	1.05	95	1.52 × .77
2500-500	18.4	18.0	18.6	19.2	1.08	63	1.38 × .57
2000-500	17.0	17.1	17.9	18.0	1.29	33	1.46 × .72
1500-500	16.0	16.4	16.7	16.9	1.43	31	1.54 × .77
1000-500	15.5	15.5	15.8	15.7	1.53	39	1.74 × .83
500-0	15.8	15.7	15.9	15.8	1.97	39	1.99 × 1.02
0	14.6	14.6	14.8	14.5	3.65	0	0
Colloidal Mill	13.6	13.5	13.8	14.0	1.81	0	0

was no consistent increase in viscosity for the 2-, 4-, 24- and 48-hour aging periods. There was a gradual decrease in the viscosity of each mix processed at pressures on the first stage ranging from 4000 pounds to zero, with the centrifugal homogenized mix a little less viscous than the unhomogenized mix. There were only 7 centipoises decrease in viscosity of the mix from 4000 pounds to zero pressure. The fat globules showed a slight increase in size from 4000 to 2500 pounds pressure with greater increases at each succeeding reduction in pressure. The number of fat globule clumps was greatest at the two-stage pressure of 4000-500 pounds. The size of the fat globule clumps did not vary much until the 1000 first stage, 500 second stage and 500 first stage pressures were reached when some increase in the size of clumps was noted.

The results of the viscosity determinations for the series of pressures at 2- and 24-hour aging periods and the size of the fat globules are shown in graph form in Figure 1. As can be seen from this figure the curves for the 2- and 24-hour aging periods run practically parallel and are very close together. The curve representing the size of fat globules shows a very gradual change from 4000 to 2500 pounds pressure with greater increases at the lower pressures.

The ice creams prepared from these mixes homogenized at the series of pressures given in Table 2 were frozen in one gallon experimental freezers. The results of the texture scores are shown in graph form in Figure 2. As can be seen from this figure the texture and body of the ice creams were good at the higher pressures of 4000 and 3000 pounds with the first evidence of coarseness at the 2500 pounds pressure. The ice creams at the lower pressures were coarse with an increase in the degree of coarseness to zero pressure. The ice creams prepared from the centrifugal colloidal mill mixes appeared to be a trifle coarser than the ice cream prepared from the unhomogenized mixes.

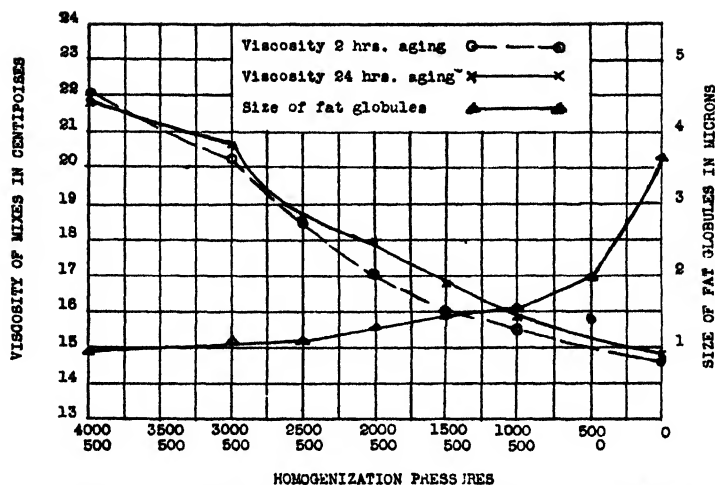


Fig. 1. Relation of homogenization pressures to viscosity and size of fat globules of ice cream mixes.

The alcohol test as suggested by Doan (1) was used to determine the stability of these mixes processed at two stage pressures of 4000 to 1000 on the first stage with a constant pressure of 500 on the second stage and with no pressure and processed with the colloidal mill. Mixtures of 4 cc. of water and 6 cc. of alcohol gave no coagulation in 5 cc. of mix with pressures ranging from 2000 to 4000 pounds on the first stage with a constant pressure of 500 pounds on the second stage but a mixture of 3 cc. of water and 7 cc. of alcohol did give a coagulation in mixes processed at the above pressures. In unprocessed mixes and those processed at the lower range of pressures and with the colloidal mill it required mixtures of 2 cc. of water and 8 cc. of alcohol to coagulate them. The unhomogenized mixes and those homo-

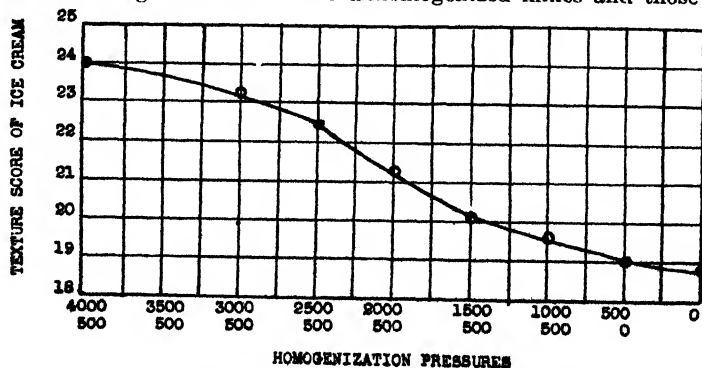


Fig. 2. Relation of homogenization pressures to texture of ice cream.

genized at low pressures and with the colloidal mill were a little more stable to the alcohol test than those homogenized at higher pressures.

To complete the pressure comparisons of two-stage homogenization, ice cream mixes prepared without gelatin containing 12 and 16 per cent fat were homogenized with a constant pressure of 2500 pounds on the first stage and the pressure on the second stage decreased from 2000 pounds to 500 pounds at 500 pound intervals and mixes without gelatin containing 12 per cent fat were homogenized with a constant pressure of 3500 pounds on the first stage and with pressures ranging from 3000 to 500 pounds at 500 pound intervals on the second stage. The viscosity, fat globules and fat globule clump measurements given in Table 3 for the 3 experiments are

TABLE 3

Viscosity in centipoises and size of fat globules and fat globule clumps of pressure homogenized ice cream mixes containing 12 and 16 per cent milk fat prepared without gelatin

PRESSURE	AGING PERIOD				AV. SIZE OF FAT GLOBULES	AV. SIZE OF FAT GLOBULE CLUMPS
	2 hrs	4 hrs.	24 hrs.	48 hrs.		
	cp.	cp.	cp.	cp.	microns	microns
12 per cent fat						
2500-2000	23.7	23.6	24.5	26.8	1.45	2.18 × 1.10
2500-1500	16.8	17.0	17.4	18.2	1.31	1.67 × .85
2500-1000	16.3	16.2	16.8	17.8	1.19	1.76 × .95
2500- 500	16.8	16.9	17.6	18.4	1.16	1.69 × .90
0	12.5	12.5	12.8	13.1	3.78	
16 per cent fat						
2500-2000	103.6	100.4	116.4	118.8	1.20	2.81 × 1.59
2500-1500	42.1	43.0	44.6	46.0	1.13	2.42 × 1.31
2500-1000	32.0	32.1	33.5	33.6	1.22	2.15 × 1.18
2500- 500	28.8	29.4	30.4	30.2	1.20	2.09 × 1.15
12 per cent fat						
3500-3000	41.4	38.6	43.9	43.9	1.07	2.19 × 1.20
3500-2500	25.6	25.8	27.3	27.3	.96	1.83 × .92
3500-2000	19.7	19.8	20.4	20.7	.84	1.48 × .73
3500-1500	18.6	19.1	24.6	19.9	.91	1.59 × .77
3500-1000	17.6	18.0	18.7	18.9	.80	1.53 × .71
3500- 500	18.1	18.6	19.0	19.6	.81	1.58 × .77

the average of determinations made on two ice cream mixes of the same composition prepared at successive intervals and processed at the pressures given in the table.

When ice cream mixes prepared without gelatin were homogenized with a constant pressure of 2500 pounds on the first stage and the pressure on the second stage was decreased from 2000 to 500 pounds at 500 pound intervals, the 2500 first-stage and 2000 pound second-stage pressure mixes were more viscous, contained larger fat globule clumps and whipped a little

less readily than the mixes with a greater difference in pressure between the first and second stage. The body and texture of the ice creams prepared from these mixes were similar.

Using the same pressures and increasing the percentage of fat gave similar results. The higher fat content made the effect more pronounced.

Other tests using a pressure of 3500 pounds on the first stage and pressures ranging from 3000 to 500 pounds at 500 pound intervals on the second stage gave the same general results.

SUMMARY

The two-stage homogenization of ice cream mixes at low pressures produced mixes which were similar in viscosity and size of fat globules to mixes processed with the centrifugal colloidal mill, except that the colloidal mill ice cream mixes contain no fat globule clumps. The ice creams prepared from these mixes containing gelatin were likewise similar in body and texture.

When ice cream mixes prepared without gelatin were homogenized with pressures on the first stage ranging from 4000 to 1000 pounds, decreasing at 500 pound intervals with a constant pressure of 500 pounds on the second stage, they showed a gradual decrease in viscosity from 4000 pounds to zero pressure. The colloidal mill mixes were a little less viscous than the unhomogenized mixes. The fat globules showed a slight increase in size from 4000 to 2500 pounds pressure with greater increases at each succeeding reduction in pressure.

The texture and quality of the ice creams were good at the higher pressures with a trace of coarseness at the 2500 pounds pressure. The ice creams prepared from mixes processed at the lower pressures were coarse and the centrifugal colloidal mill ice cream was a trifle coarser than the unhomogenized ice cream.

When ice cream mixes prepared without gelatin were homogenized with a constant pressure of 2500 pounds on the first stage and the pressure on the second stage was decreased from 2000 to 500 pounds at 500 pound intervals, the 2500 first-stage and 2000 pound second-stage pressure mixes were more viscous, contained larger fat globule clumps and whipped a little less readily than the mixes with a greater difference in pressure between the first and second stage. The body and texture of the ice creams prepared from these mixes were similar.

REFERENCES

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- (2) HENING, J. C. Some observations on the basic viscosity of ice cream mixes. *JOUR. DAIRY SCI.* 14: 84-92. 1931.
- (3) WHITAKER, R. A device for reducing an ice cream mix to its basic viscosity. *JOUR. DAIRY SCI.* 12: 285-287. 1929.

THE THIRTY-FIRST ANNUAL MEETING OF THE AMERICAN DAIRY SCIENCE ASSOCIATION

R. B. STOLTZ
Secretary-Treasurer

On June 15 to 19, inclusive, 1936, the American Dairy Science Association convened at State College, Pennsylvania, for their thirty-first annual meeting. The program, given in the June issue of the JOURNAL OF DAIRY SCIENCE, was arranged by the program committee headed by S. I. Bechdel. The July issue of the JOURNAL contains the abstracts of the various papers presented.

This is the first year that a registration fee has been charged. A fee of \$1.00 was charged the members, a fee of \$2.00 was charged the non-members, and there was no registration fee for ladies and children.

There was a large attendance at the meeting, 35 states of the 48 as well as Canada and Australia being represented. 292 of the 362 registrants were members. 135 ladies and 102 children made the total attendance 599. The registration by states was furnished by M. A. Farrell.

In the last few years there has been a noticeable increase in the bringing of the entire family to the meetings; thus the ladies and children are coming to feel that the meeting is an annual one for them as well as for the men.

Tuesday evening was the first social get-together. The families, members, and guests met in the second floor lounge of Old Main, renewing friendships made at previous meetings and making new acquaintances.

With the compliments of the Cherry-Burrell Corporation, a mountain tour for the wives, young folks, and children of registrants was planned for Wednesday. Wednesday evening there were two dinners given, the Creamery Package Manufacturing Company being host.

Thursday morning the children had their play supervised at the Municipal Playground or were taken on a mountain hike. At this time the ladies visited places of interest on the campus or played golf. Thursday afternoon the children and young people went to Glennland Pool where they spent the time swimming and playing. During this period the ladies were entertained at the lovely Nittany Lion Inn. The annual banquet was held Thursday night at McAllister Hall. Later in the evening there was dancing in the Old Main, the music being furnished by a campus orchestra.

OPENING SESSION

The opening session of the Association was called to order by President, H. A. Ruehe, at 7:30 p.m. Tuesday evening, June 16, 1936, in the College Auditorium.

Registration by states

COUNTRIES OR STATES	REGISTRANTS		WOMEN	CHILDREN	TOTAL
	Members	Non-members			
Australia	—	1	1	—	2
Canada	4	1	2	2	9
California	1	—	—	—	1
Colorado	—	1	1	—	2
Connecticut	7	—	3	—	10
Delaware	—	1	—	—	1
Dist. of Columbia	25	3	10	11	49
Florida	1	—	—	—	1
Idaho	1	—	—	—	1
Illinois	17	5	12	8	42
Indiana	6	—	3	1	10
Iowa	8	—	4	—	12
Kansas	5	1	—	—	6
Kentucky	5	—	1	2	8
Louisiana	1	—	—	—	1
Maine	—	2	—	—	2
Maryland	6	2	2	2	12
Massachusetts	10	—	1	—	11
Michigan	12	—	3	5	20
Minnesota	6	—	5	1	12
Missouri	8	2	5	4	19
Montana	1	—	—	—	1
Nebraska	6	—	3	2	11
New Hampshire	4	3	—	—	7
New Mexico	1	—	—	—	1
New Jersey	16	3	2	—	21
New York	40	10	17	6	73
North Carolina	4	—	3	3	10
Ohio	17	3	12	9	41
Oklahoma	3	—	—	—	3
Pennsylvania	41	26	30	34	131
South Dakota	1	—	—	—	1
Tennessee	1	—	—	—	1
Texas	1	—	1	—	2
Vermont	8	1	7	8	24
West Virginia	8	1	3	12	24
Wisconsin	12	2	3	4	21
	294	68	135	102	603

R. D. Hetzel, president of Pennsylvania State College, gave the welcoming address.

H. A. Ruehe, president of the American Dairy Science Association, then gave an address covering the following:

Thanking President Hetzel for his kind words of welcome, Dr. Ruehe also expressed his pleasure in having the opportunity of being at Penn-

sylvania State College. He then gave a brief history of the Association stressing its founding, its scientific growth, and its position today.

Unlike a decade ago, now science and agriculture and dairying are working closely together; and research in these fields should be practical as well as theoretical.

Dr. Ruehe then spoke of the JOURNAL OF DAIRY SCIENCE, of its growth and the recent addition of the abstracts. He thanked those who had given so generously of their time and talent and urged every member to aid in increasing the circulation.

The President then expressed the desire of the officers to render the best service possible to the membership of the Association and the dairy industry.

Thanking our hosts for the instruction and inspiration so generously offered, Dr. Ruehe closed his address.

SECRETARY-TREASURER'S REPORT

Membership

The problem of increasing our membership is one of the most important problems that the Association has to face. The dairy industry should furnish at least 1,000 members for our Association. The leaders of the dairy industry are becoming professional men. Those men, who are college trained, should consider themselves as professionals. This will necessitate their being associated with a scientific organization as well as being kept posted on the latest scientific work in the dairy field. Our Association publishes the JOURNAL OF DAIRY SCIENCE to furnish the latter.

This year we have increased the cost of the publication by the addition of printing the abstracts.

For the past three years we have put on a membership campaign and have increased our membership each year, but our serious problem is that more than half of the number of members we have added to our membership list are lost by lapsing. Our problem then is to not only get new members, but to hold a greater percentage of the members which we now have. Following is a list of members, old and new by States:

STATE	OLD	NEW	STATE	OLD	NEW
Albania	2	2	Kentucky	5	—
Arizona	2	2	Louisiana	2	6
Arkansas	1	—	Maine	2	3
California	36	48	Maryland	12	4
Colorado	1	3	Massachusetts	15	8
Connecticut	16	10	Michigan	21	6
Delaware	—	—	Minnesota	32	3
Dist. of Columbia	22	11	Mississippi	3	—
Florida	5	1	Missouri	19	2
Georgia	3	2	Montana	5	1
Idaho	4	—	Nebraska	9	1
Illinois	48	25	Nevada	1	—
Indiana	17	—	New Hampshire	5	—
Iowa	16	4	New Jersey	10	7
Kansas	8	—	New Mexico	3	3

New York	70	16	Texas	5	3
North Carolina	4	2	Utah	5	—
North Dakota	3	—	Vermont	9	2
Ohio	45	27	Virginia	7	1
Oklahoma	7	1	Washington	17	3
Oregon	7	1	West Virginia	8	1
Pennsylvania	37	24	Wisconsin	33	4
Rhode Island	—	—	Wyoming	1	1
South Carolina	4	1	Canada	13	4
South Dakota	3	2	Foreign	11	5
Tennessee	4	5		—	—
			Total	617	215

Credit is given not by the membership committee who obtains the new members, but the state is credited where the new member is located. This shows that we had a membership of 734 last year. On July 16 of this year we have taken in 215 new members, and had 117 members lapse. It is our desire to interest at least one half of the lapsed membership to renew this year and to increase our new members, so that our total membership at the end of this year will be not less than 800.

GENERAL BUSINESS SESSION

Friday, Morning

8 to 9 A.M., June 19, 1936

College Auditorium, Central Campus

O. F. Hunziker, Chairman of the Journal Management Committee, submitted the following recommendations:

- (1) To charge for all reprints in excess of the 25 complimentary copies on the basis of the present rate for the first 50 copies and at the same rate for each 100 copies thereafter.
- (2) To charge authors \$5.00 per page in excess of 12 pages, instead of the present charge of \$4 00.
- (3) To consider publication of abstracts of literature on dairy production.

The Secretary-Treasurer then gave a report on membership. The Treasurer's report for the year 1935 was read and upon motion duly seconded was accepted. The report follows:

10 Knowles Avenue,
Kensington, Maryland
February 1, 1936

Mr. Roy R. Graves
Secretary-Treasurer
American Dairy Science Association
Washington, D. C.

Dear Mr. Graves:

In accordance with your request, I have made an audit of the records of the American Dairy Science Association, recorded necessary adjustments, closed the books as of December 31, 1935, and have drawn up the following statements and comments:

EXHIBIT "A"—BALANCE SHEET

As at December 31, 1935

EXHIBIT "B"—STATEMENT OF PROFIT AND LOSS

For the period December 31, 1934 to December 31, 1935

EXHIBIT "C"—BANK RECONCILIATION STATEMENT

COMMENTS

Cash in Bank, as shown by the books, was reconciled with bank statements furnished by McLachlen Banking Corporation of Washington, D. C., (See Exhibit "C"). Cash items held for collection represent two money orders held for collection by bank, not included in 1935 deposits.

Bonds appear on the balance sheet at par and were recorded according to your information.

Accounts Receivable—Returned checks were set up in December 1934 from information received from your bank statements. Information received from you makes it appear probable that all these checks were made good, although improperly credited again to membership fees and subscriptions. They were, therefore, deducted from 1935 income.

Accounts Receivable—Advertising totaling \$77.69 was set up from information received from the Editor. The Editor's statement showed \$83.60 due, however, \$5.91 was received on December 31, 1935.

The following discrepancy between the Editor's advertising statement and the records of the American Dairy Science Association is shown below:

	Editor	Secretary-Treasurer
Accounts Receivable 1934	\$ 79.55	\$ 40.82
Accounts Receivable 1935	77.69	77.69
Advertising 1935	1,235.89	1,318.80

The discrepancy is probably accounted for by the Secretary-Treasurer's inclusion of some receipts in 1935 income which rightfully belonged in 1934 due to lack of proper information from Science Press.

I have estimated the inventory taken by Professor Dahlberg, as Editor, for 1935 Journals at \$100.00. In accordance with last year's precedent, 80% of this amount has been set up as a reserve to decrease the inventory to the amount of probable future sales. This inventory included only 1935 Journals on hand at December 31, 1935. A cost of sales, therefore, could not be computed.

The Profit and Loss Statement shows the amount of purchases as expenses under the various headings. These costs were recorded on a cash basis from the Cash Book.

Deferred income represents payments made in 1935 on 1936 subscriptions and memberships.

Respectfully submitted,

CHARLES E. R. ADAMS, *Public Accountant*

AMERICAN DAIRY SCIENCE ASSOCIATION
WASHINGTON, D. C.

EXHIBIT "A"

BALANCE SHEET

As at December 31, 1935

Assets

Cash in Bank	\$3,651.82	
Cash—items held for collection	10.35	\$3,662.17
ACCOUNTS RECEIVABLE—		
Advertising—December 1935 Journal	77.69	
Returned checks	15.00	
Accrued Interest Receivable	60.00	152.69
Inventory—Journals (see comments)	625.00	
Less Reserve	500.00	125.00
Investments—Bonds		4,000.00
TOTAL ASSETS		\$7,939.86

Liabilities and Capital

ACCOUNTS PAYABLE		3.00
Deferred Income		982.12
CAPITAL:		
Capital—December 31, 1934 per Balance Sheet of that date	\$5,779.29	
Add Estimated value of Journal Inventory for year 1935	\$20.00	
Less loss on collection of Accounts Receivable	.40	\$ 19.60
Net profit for period	1,155.85	\$6,954.74
TOTAL LIABILITIES AND CAPITAL		\$7,939.86

AMERICAN DAIRY SCIENCE ASSOCIATION
WASHINGTON, D. C.

EXHIBIT "B"

STATEMENT OF PROFIT AND LOSS

For the period December 31, 1934 to December 31, 1935

INCOME:

Membership Fees	\$3,488.23
Subscriptions	2,931.20
Advertising	1,318.80
Single and Back copies	52.12
Reprints	83.56

GROSS OPERATING INCOME

\$7,873.91

OPERATING EXPENSES

Journal	5,313.03
Reprints	71.10
Handling and Advertising Subsc.	261.10
Postage and Stationery—S. P.	21.86
Miscellaneous Expense—S. P.	126.36
Editorial Expense:	
Salary	\$500.00
Telegrams & Postage	53.33
	553.33
Secretary-Treasurer	
Salary	200.00
Postage & Expenses	20.00
	220.00
Divisional Allotment	75.00
Accounting and Bookkeeping	25.00
Association Stationery	29.00
Federal Check Tax	.12
Collection and Exchange	1.87
Miscellaneous	43.91
Annual Meeting	40.25

TOTAL OPERATING EXPENSE

6,781.87

NET OPERATING PROFIT

1,092.04

NON-OPERATING INCOME:

Bond Interest	105.00
Less Bond Premium on Bond Purchased	41.19
	63.81

NET PROFIT TRANSFERRED TO "EXHIBIT A"

1,155.85

BANK RECONCILIATION STATEMENT

EXHIBIT "C"

American Dairy Science Association, Washington, D. C.
As at December 31, 1935

Bank Balance, December 31, 1935		\$ 4,577.74
Add outstanding Deposits		
Science Press	\$ 237.49	
Science Press	200.86	438.35
		<hr/>
		\$ 5,016.09
Deduct Outstanding Checks		
The Maruzen Company	5.00	
Charles Shepardson	25.00	
Western Union	.63	
Science Press	815.41	
Charles Adams	25.00	
Cash—Secretary-Treasurer	5.00	
Science Press	483.38	
Crowell Publishing Company	4.85	1,364.27
		<hr/>
Adjusted Bank Balance		\$ 3,651.82
Book Balance December 31, 1934	3,950.40	
Add Cash Receipts	9,455.25	12,405.65
		<hr/>
Deduct Cash Disbursement		8,753.83
		<hr/>
Book Balance December 31, 1935		\$ 3,651.82

The recommendation of the Board of Directors was then read:

1. A notice of dues be sent to the membership the latter part of October, and that the January issue of the Journal not be sent to members until after they had paid their dues. Recommendation adopted.

2. That the names of all applicants for membership be published in the JOURNAL OF DAIRY SCIENCE. Recommendation adopted.

3. The following amendment was recommended: The Board of Directors shall consist of ten members, as follows: Six elected by the active membership, the retiring President, the President, the Vice-President, and Secretary-Treasurer, who shall be an ex-officio member.

At the first election under this constitution as amended, one director shall be elected for a term of one year, one for a two-year term, and two for a three-year term, thereafter two directors shall be elected each year, whose terms of office shall be three years. The terms of all directors begin October 1.

Upon motion by H. B. Ellenberger and seconded by E. C. Thompson the amendment was carried.

Upon motion duly seconded the action of the Board of Directors was adopted.

E. J. Perry, Chairman of the Extension Section, then gave the following report:

REPORT OF EXTENSION SECTION

The Extension Section continued the policy adopted in 1935 of having committee reports presented in the regular sectional meetings. Four committees, namely, the Testing, Breeding, Feeding, and Calf Club committees gave reports of surveys and studies made by the members on methods and subject matter presentation. These committee reports gave evidence of much work and preparation on the part of the committee members.

The Exhibit of Extension projects and methods was the most complete and the best organized of any of the previous two years.

Twenty states and the Bureau of Dairy Industry prepared exhibits. These exhibits were explained and discussed at a special session.

The regular business session was held Thursday, June 18, 1936, S. J. Brownell, of New York, being elected secretary. According to action taken in 1935, the 1936 secretary becomes vice-chairman for 1937 and the 1936 vice-chairman becomes the 1937 chairman. The chairman for 1937 will be C. L. Blackman, of Ohio, and the vice-chairman, Earl Schultz, of Iowa.

We are proud to report a membership of 62 extension men with over 50 regular attendance at this convention.

E. J. PERRY, *Chairman*
EARL SCHULTZ, *Secretary*
Extension Section
June 19, 1936

Upon motion duly seconded, the report was received and approved.

L. M. Thurston, Chairman of the Manufacturing Section, gave a report of the Manufacturing Section, which was, upon motion duly seconded, received and approved.

REPORT OF MANUFACTURING SECTION

The meetings of the manufacturing section this year have been well attended and interest has been maintained well throughout the sessions, thanks to the cooperation of the authors of papers in keeping within the time limit prescribed in nearly all cases.

At the judging demonstration on June 16 approximately 100 people were present and a profitable discussion of the ice cream score card with regard to standardization of the evaluation of defects developed.

Some very helpful and much needed work has been accomplished by this section during the past few years through the activity of committees. Committees at work during the year were as follows:

Chemical methods for the analysis of milk and dairy products. (Thirty members divided into subcommittees. E. S. Guthrie, Chairman.)

Bacteriological methods for the analysis of milk and dairy products. (Twenty-nine members divided into subcommittees. H. Macy, Chairman.)

Judging dairy products. (H. W. Gregory, Chairman.)

Methods of determining the curd tension of milk. (L. H. Burgwald, Chairman.)

Revision of score cards for the sanitary inspection of dairy farms and milk plants. (C. J. Babcock, Chairman.)

All these committees have been active throughout the year. Many methods for the chemical, bacteriological and physical examination of milk and dairy products are being

studied by certain of these committees. Some of these methods already found satisfactory, have been published in the JOURNAL, and many more undoubtedly will be made available as time goes on. Sentiment of members regarding a suggestion by Dr. Macy was such that it was decided to appoint a committee to study the feasibility of supplying a loose-leaf manual of the methods reported by these committees. It is proposed that the manual would be sold on a subscription basis and kept up to date periodically by furnishing separates to be incorporated in the manual.

The committee on the judging of dairy products has been cooperating closely with the Dairy and Ice Cream Machinery and Supplies Association in conducting the annual contest in judging dairy products and selecting students to receive the scholarship awards offered by the above mentioned Association. This committee reports that the Dairy and Ice Cream Machinery and Supplies Association is well pleased with the present system of awarding scholarships on the basis of teams rather than individuals.

The manufacturing section took action directing that committees be appointed by the retiring chairman rather than by the incoming chairman. This action was taken in order that the committees may be appointed more promptly than has been possible in the past.

Officers elected to take charge of the section October 1, next, are:

P. H. Tracy, Chairman

J. C. Marquardt, Secretary.

L. M. THURSTON, *Chairman*

Mr. K. S. Morrow, Chairman of the Production Section, gave a report of the Production Section, which was, upon motion duly seconded, received and approved.

REPORT OF THE PRODUCTION SECTION

The Production Section met in Room 8 of the Dairy Building at the times scheduled on the program. K. S. Morrow, of New Hampshire, was in the chair. All the papers but one that were listed on the program were given. At the afternoon session on Wednesday, June 17, the average attendance was 180, at the A. M. session on Thursday, June 18, the average attendance was 125, and at the P. M. session on the same day about 100 were in attendance.

At the business session of the Production Section, held at 1:00 P. M. on June 18, reports of the Students Judging Committee, the Breeds Relations Committee, and the Pasture Investigations Committee were read, and after some discussion were adopted and filed with the Secretary. The report of the Student Judging Committee introduced one important change which allows admission to the Students' Judging Contest of Teams from schools in the United States other than Land Grant Colleges, provided such institutions offer a full degree course in agriculture with a full major in Dairy Production in a division of Animal Husbandry or Dairy Husbandry whose application is approved by the rules committee.

In the report of the Breeds Relations Committee an important change consisted in permitting equal part sampling for composite testing.

The new standing committees of the Production Section were appointed as follows:

Breeds Relations Committee:

S. M. Salisbury (Ohio), Chairman—1 year

R. T. Harris (Wisconsin)—1 year

C. M. Shepardson (Texas)—2 years

E. M. Shultz (Iowa)—2 years

C. E. Wiley (Tennessee)—3 years

J. G. Hays (Michigan)—3 years

Students Judging Contest Committee:

I. W. Rupel (Wisconsin), Chairman

P. Reaves (Virginia)

E. Hanson (Iowa)

J. F. Kendrick (Washington, D. C.)

J. R. Dice (North Dakota)

It was moved, seconded, and adopted that the special committee on methods of measuring results of Pasture Investigations be continued, this committee to be made up as follows:

R. H. Lush (Louisiana) Chairman

I. R. Jones (Oregon)

C. B. Bender (New Jersey)

G. Bohstedt (Wisconsin)

R. B. Becker (Florida)

It was moved, seconded, and adopted that a committee of three be appointed by the chair, to investigate on standard methods of the Manufacturing Section and include methods of experimentation and analysis of interest to the Production Section. The following committee was appointed to conduct this study:

A. E. Perkins (Ohio), Chairman

W. E. Peterson (Minnesota)

C. F. Huffman (Michigan)

It was moved, seconded, and passed that the matter of including abstracts of Dairy Production papers in the JOURNAL be referred to the JOURNAL Management Committee.

Consideration was invited to having a vice-chairman of the Production Section who would automatically become chairman during the following year, and as a result a motion making such a system effective was adopted.

The Nominating Committee, of which Dr. Gullickson, of Minnesota, was chairman, presented the following names for officers in the Production Section:

For Chairman	{	R. B. Becker (Florida)
	{	F. W. Atkeson (Kansas)
For Vice-chairman	{	S. I. Bechdel (Pennsylvania)
	{	W. E. Krauss (Ohio)
For Secretary	{	I. W. Rupel (Wisconsin)
	{	D. Fount (Idaho)

Upon vote of the 45 members of the Production Section present, F. W. Atkeson was elected Chairman, W. E. Krauss, Vice-chairman, and I. W. Rupel, Secretary.

The business meeting of the Production Section adjourned at 2:30 P. M. This report is respectfully submitted by

K. S. MORROW, *Chairman*W. E. KRAUSS, *Secretary*

President Ruehe then appointed a committee consisting of L. M. Thurston, F. C. Button, and A. C. Dahlberg to act for the Association on an exhibit to be held by the American Association for the Advancement of Science at Atlantic City in the Court of Dairy Industries to show the results of research and scholarship.

Chief O. E. Reed, Chairman of the Committee on National Research Councils, gave the following report, and upon motion duly seconded, it was adopted.

Upon motion by J. H. Frandsen, seconded by O. F. Hunziker, it was voted that Chief O. E. Reed represent the American Dairy Science Association upon this committee for the ensuing year.

The nomination committee then gave their report as follows:

Our Constitution with the new amendment, increasing the Board of Directors to six active members, requires the nomination of the following slate for the ensuing year:

Vice President

- 2 Directors for 3 year terms
- 1 Director for 2 year term
- 1 Director for 1 year term

Your committee on nominations have met and beg to recommend the following names for nominations:

Vice President:

- H. W. Gregory, Indiana
- J. W. Linn, Kansas

Directors:

For 3 year term:

- F. C. Button, New Jersey
- H. O. Henderson, West Virginia
- E. G. Hood, Canada
- Earl Weaver, Oklahoma

For 2 year term:

- J. A. Nelson, Montana
- C. N. Shepardson, Texas

For 1 year term:

- H. P. Davis, Nebraska
- M. J. Rogan, Missouri

Respectfully submitted

The Nominating Committee

- C. R. GEARHART
- A. H. KUHLMAN
- HAROLD MACY
- E. J. PERRY
- O. F. HUNZIKER, *Chairman*

The resolutions committee then submitted the following report:

Whereas the American Dairy Science Association assembled in Annual Convention at the Pennsylvania State College at State College, Pennsylvania, has enjoyed a most satisfactory program and the many courtesies extended them, therefore be it resolved:

- (1) That the membership and wives tender their deep appreciation to the staff of the Pennsylvania State College and the organizations which have contributed to the success of the 81st annual meeting.

(2) That the program committee be commended for the arrangement of papers according to subject matter and further extension of the symposium idea be recommended.

(3) That those who present papers before the general Association or sectional meetings make definite preparations to the end that their papers be given within the time limit allotted so as not to jeopardize interest in or curtail presentation of succeeding papers on the same program.

That in most instances those papers presented without reading are more interesting, more effective, and stimulate more discussion than those read.

(4) That an appreciation be extended for the work of the several committees on standard methods of analytical procedure for dairy products and that this work be further extended into other fields of dairying.

(5) That the Association feels its loss in the death of one of its members, Professor Richard W. Smith, formerly of the University of Vermont, and that it expresses its deepest sympathy to the bereaved family.

(6) Whereas the members of the American Dairy Science Association are vitally interested in education, be it resolved that the program committee each year be instructed to arrange to have at least one speaker on the general program to discuss such subjects as the aims and objectives in education and the means of attaining these ends.

Resolutions Committee

J. A. NELSON

L. M. THURSTON

C. L. BLACKMAN

R. H. LUSH

W. E. PETERSEN, *Chairman*

Upon motion duly seconded the report was accepted.

President Ruehe then reported that the Board of Directors had accepted the invitation from the University of Nebraska to meet in Lincoln at a suitable date in June 1937.

J. B. Fitch moved and J. H. Frandsen seconded that a committee be appointed to report back to the Association regarding the attitude of the American Dairy Science Association on the standardization of milk for butterfat. The President appointed the following committee: P. F. Sharp, J. H. Frandsen, C. L. Roadhouse, A. D. Burke, and W. D. Dotterrer.

Upon motion duly seconded the meeting was then adjourned.

MEETING OF BOARD OF DIRECTORS

June 18, 1936, 12:00 noon.

Present: H. A. Ruehe, L. A. Rogers, C. R. Gearhart, and R. B. Stoltz.
Absent: R. R. Graves and Martin Mortensen.

Mr. Gearhart moved and Dr. Rogers seconded that the Secretary be authorized to notify the membership of their dues for the ensuing year in the month of November and that the Journal be not sent to delinquent members.

Dr. Rogers moved and Mr. Gearhart seconded that the names of all applicants for membership in the American Dairy Science Association be published in the Journal.

H. P. Davis came before the Directors and invited the Association to hold its next meeting at the University of Nebraska at Lincoln. Upon motion by Dr. Rogers and seconded by Mr. Gearhart, the invitation was accepted.

O. F. Hunziker, Chairman of the Journal Management Board, then submitted the following report: Your committee on Journal Management begs to make the following recommendation—

1. To charge for all reprints in excess of the 25 complementary copies on the basis of the present rate for the first 50 copies and at the same rate for each 100 copies thereafter.
2. To charge authors \$5.00 per page for each page in excess of 12 pages.
3. To consider publication of abstracts of literature on dairy publication.

Upon motion by Mr. C. R. Gearhart and seconded by Mr. R. B. Stoltz, the recommendations were adopted.

A report was then read from the committee on Solids-not-Fat-Standards.

Upon motion by L. A. Rogers and seconded by C. R. Gearhart the report was laid on the table. Upon motion duly seconded the meeting was then adjourned.

June 18, 1936—4 P.M.

Old Main Building

Present—H. A. Ruehe, R. R. Graves, C. R. Gearhart, R. B. Stoltz, A. C. Dahlberg, L. A. Rogers.

Absent—Martin Mortensen.

The following amendment was proposed:

That section 5 of the By-Laws of the American Dairy Science Association referring to Associate membership be changed to read as follows:

“Associate Membership of this Association shall consist of upper division and graduate students who are majoring in dairying or dairy industry in a regularly organized college or university. Applications for Associate Membership must carry the approval of the head of the department of dairying in the institution where the student is enrolled. Members of local chapters of the American Dairy Science Association in institutions where such student organizations exist are eligible for recommendation for membership as Associate Members of the American Dairy Science Association when their applications are approved by the head of the department of dairying in the institution where the chapter is located. Associate Membership expires one year after the holder ceases to be enrolled as a student, but an associate member may then become an active member upon payment of active membership dues.”

After discussing at some length the amendment regarding the associate membership the thought was expressed that this matter be laid over until

our next meeting, at which time it should be brought up for further consideration. This will permit the members a year's time to consider as to whether or not the associate membership should be continued. Upon motion by R. R. Graves and seconded by C. R. Gearhart the amendment was laid on the table.

The question then arose as to whether or not the Association could be of greater financial aid to the various division meetings. The Board then instructed the Secretary to advise the officers of the divisions that we are sympathetic with their financial conditions and problems, but that we are not able at the present time to increase the allotment made to them. The Board suggests that the various divisions adopt the same policy as our organization in making a registration charge in order to defray the expenses at the division meetings. Upon motion duly seconded the Board was then adjourned.

EDITOR'S REPORT FOR 1935 TO COMMITTEE ON JOURNAL MANAGEMENT

On account of the labor involved in the organization of the publication of abstracts of literature on Milk and Milk Products, the editor has been at some handicap in finding time to actually digest the activities of the JOURNAL OF DAIRY SCIENCE for 1935. This report is, therefore, not as complete as desired.

MAILING LIST

There was a substantial increase in the total paid mailing list of the Journal for 1935. Science Press mailing cards for 1934 showed a paid list of 1157 while the list for 1935 was 1344 of which 727 were members and 617 were subscribers. The trend toward a larger proportion of members to subscribers is undoubtedly desirable and due primarily to the activity of the Association.

ADVERTISING

The total pages of advertising in 1935 were 56½ with 58½ in 1934. The maintenance of advertising in 1935 was not particularly good as there should have been a decided increase but the total advertising is actually as good as it has ever been in the JOURNAL OF DAIRY SCIENCE.

The advertising rates have not changed and are somewhat low as has been mentioned on several occasions. The cost of securing and publishing advertisements is not high but it increased this year due to increased circulation.

After discussion with the Secretary-Treasurer it was decided to have advertising solicited thru his office rather than by the editor. After many years of effort a change of policy and of the individual soliciting advertising is undoubtedly good and it is to be hoped that high class advertising may be increased in 1936. The abstract service should be an aid and some advertisers have mentioned the increased value of the Journal to them.

Two companies have requested preferred space in the text and 12 full pages of advertising were lost by the decision to keep ads out of the text. It is believed that the Journal must continue the policy of restricted space for advertising at the beginning and end of the Journal.

MATERIAL PUBLISHED

The Journal published 79 manuscripts, 10 Association announcements, the annual program, the membership lists, and devoted the July number to the abstracts of papers given at the annual meeting. It furnished 450 reprints of the July number to members attending the annual meeting. This is the year of greatest printing service to the Association.

The Journal is still up-to-date in the publication of manuscripts as was reported last year for 1934. Manuscripts have regularly appeared in the Journal within six months or less after date of receipt.

REPRINTS

Consideration has been given by the editor to the charge for reprints. Comparative data are given in table 1 to show costs to authors or educational agencies printing in several Journals.

Our Association now sells reprints below the cost of state printing. This may be a desirable policy but it should be discussed. It would seem to be good business to furnish our members with 50 reprints at the present cost price and to make a reasonable profit on additional reprints. This could easily be accomplished by charging the same total amount for each 100 reprints as it now charged for the first 50. As shown in table 1 this would give a charge of 5½ cents each for a 16 page article, an increase of \$2.80 per 100 reprints above the present rate.

PAGE STYLE

Several individuals have called the editor's attention to the trend toward two column pages and have recommended this style for the Journal. After corresponding with Science Press the editor is inclined to believe that the present printed page should not be altered. A narrow column of three inches is quite suitable for scientific printing but the two to two and one-half inch column as used for popular writings is too narrow for scientific writings.

ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

The agreement for the publication of abstracts of literature on milk and milk products was made with the International Association of Milk Dealers and of Ice Cream Manufacturers just in time to rush some abstracts into the January, 1936 JOURNAL. Although this activity actually began in 1936 the organization began in 1935.

This service includes all of the State and Federal Experiment Stations, several European Experiment Stations, and 49 Journals. There is a group of 5 editors, 86 abstractors, and an editorial committee of 6 who are all active in this service. It requires 90 letters to send one communication to each abstractor and editor. The extensiveness of the arrangement is shown by the attached directory taken from the JOURNAL.

The work of organization is over and the printing of back abstracts has been completed. The Journal now serves as the continuation of the abstracts previously published independently by the other two Associations.

The publishing agreement called for an increase of 400 above our mailing list of 1935 or a total paid list of 1744. The mailing list was 1549 on May 14 or 195 short of the final goal for the year. It is too early to anticipate the final mailing list but continued efforts will be needed to reach it. The returns thus far are very gratifying. It is almost needless to state that the Secretaries of the three Associations have taken the leading part in promoting the mailing list.

PLANS FOR THE IMMEDIATE FUTURE

The Journal is serving our Association and the industry well and its usefulness has been extended yearly. There always seems to be some important change which should be made.

It is evident that the abstract service should be extended when possible to include dairy cattle. This problem should be discussed at the annual meeting to ascertain the need for the service and a method to increase circulation to permit the development of this service, if desired.

Another activity which is badly needed is a standardization of usage in common dairy terms. The Dairy Science Association is the proper body to set the standards for good dairy science language. After considerable correspondence and thought it is evident that there is a real need for this service and that it can best be done by the editor and editorial staff acting with power granted by the Association.

RECOMMENDATIONS

1. Obtain the opinion of the Association as to the desirability of increased charges for reprints purchased over 50 and the elimination of free reprints.
2. Consider the feasibility of extending the abstract service to include dairy cattle.
3. Secure approval of the Association for the editorial staff to establish standard dairy terms for uniformity of style in the Journal.

CHARGES FOR JOURNAL REPRINTS
First 50 Copies

	Complimentary	4 pp.	8 pp.	16 pp.
Science	0	3.70	5.40	7.60
Dairy Science	25	1.55	2.75	5.25
Horticultural Science	0	3.05	5.00	—
Agronomy	0	2.65	4.25	7.45
<i>Extra 100 Copies</i>				
Science		0.75	1.20	1.80
Dairy Science		0.80	1.50	2.80
Horticultural Science		2.70	5.50	—
Agronomy		1.60	2.70	4.90

The 5-year average cost of printing Technical Bulletins by the New York Agricultural Experiment Station ordered in average lots of 3,900 copies was 5 cents per copy. Minimum order required to secure these prices was 1000 copies. Cost in JOURNAL OF DAIRY SCIENCE without covers for 28 page reprints is 4.9 cents after ordering 50 copies at 9.1 cents each. Minimum order required to secure low price is 150 copies.

REPORT OF JOURNAL MANAGEMENT COMMITTEE

State College, Pa.

June 19, 1936

Another milestone in the history and development of this Association and of the JOURNAL OF DAIRY SCIENCE has been turned; I refer to the publication of the Abstracts of the literature of milk and milk products. This enterprise has been successfully

launched and is now well under way. It began on schedule time with the publication of the January issue.

The tentative agreement made at last year's meeting with the International Association of Milk Dealers and the International Association of Ice Cream Manufacturers was signed late in November by all parties concerned, with but slight changes in wording and substantially unchanged in principle. The figures available so far suggest that while the increased size of the JOURNAL with the Abstracts has increased the cost of the JOURNAL very appreciably, we should at least break even or better by the end of this year.

Due to the delay in ratification of the agreement, our regular announcement for subscriptions and our solicitations for advertising contracts had to be sent out without any mention of the Abstracts. But in spite of this handicap our returns have been very gratifying and they will naturally increase due to the business-getting lever of the Abstract Service. Indeed, the Abstract Service may well be looked upon as our most promising financial asset.

It appears pertinent to mention in this connection that the JOURNAL has made a considerable operating profit in the past, averaging over \$1,000 annually. If, therefore, this first year of the promotion of the Abstract Service should show a slight loss, such deficit would be amply covered by the accumulated reserve. Let us not be unmindful that the fundamental and permanent strength of our organization lies in our permanent membership. And you members may know of dairy teachers whom we need and who in turn need our Association and all it stands for. Further, when members, and particularly you men at the dairy schools and experimental stations are answering technical inquiries, there appears no good reason why such inquirers should not be referred to the JOURNAL OF DAIRY SCIENCE, thus selling them on the idea of subscribing for the JOURNAL.

The progress that has been made and the success that has been achieved have been due to a large measure to the generous cooperation on the part of so many of you members in your membership drives and abstracting service.

At the beginning of this latter enterprise we had to limit the field of literature covered due to financial returns. Since the milk and ice cream associations sponsored for the abstracting of the literature of milk and ice cream it was decided to confine the abstract service to milk and milk products for the first year and then branch out into dairy production as soon as we could see our way clear to extend the abstract service. The publication of abstracts on the literature of dairy production and the commercial dairy cattle business are under serious consideration right now and we are anxious to extend this service just as soon as it becomes financially feasible.

The committee on JOURNAL Management wishes to repeat its sincere appreciation of the unflinching cooperation of members and to assure you that the administrative affairs of your JOURNAL are in good hands. The busy men on the firing line, your able JOURNAL Editor, A. C. Dahlberg, and your experienced permanent Secretary, R. B. Stoltz, who are taking care of the great mass of daily details of administration are rendering this Association a priceless service of untiring labor and wise judgment. Their efforts merit our whole-hearted support and our active cooperation.

O. F. HUNZIKER, *Chairman*

JOURNAL OF DAIRY SCIENCE

VOLUME XIX

DECEMBER, 1936

NUMBER 12

CLEANING DAIRY EQUIPMENT WITH TRISODIUM PHOSPHATE

L. A. ROGERS AND FRED R. EVANS

*Bureau of Dairy Industry, U. S. Department of Agriculture,
Washington, D. C.*

When the hand separator displaced to a large extent the factory separation of milk, the quality of the cream for buttermaking was seriously impaired. This was due partly to the less frequent deliveries to the creamery and partly to the failure to properly clean and sterilize the separators on the farm. In some cases improper cleaning is due to negligence, but frequently it may be ascribed to the inherent difficulties in making bacteriologically clean an apparatus with so much surface and so many corners to hold moisture.

Milking machines are also difficult to keep properly cleaned and free from bacteria, and it is well known that under some conditions they may cause serious contamination of the milk.

Dairy utensils even when properly cleaned of visible dirt may harbor large numbers of bacteria which, if the temperature is favorable, may multiply enormously in the film of water left on the surfaces. Not only is it difficult to keep a separator properly cleaned under the best conditions, but, due to the methods followed by many creameries in buying cream, careless habits have developed and the separator may be washed only once each day, and in some cases less frequently.

SEPARATORS

The effect of improper care of the separator is illustrated by Table 1. In this case the hand separator was washed and steamed after the morning separation, but in the evening was allowed to stand without washing and used in the morning to separate a fresh batch of milk. The bacteria count of the milk was determined in the milk before separation and in the mixed milk and cream after separation. For this purpose milk powder-tomato juice agar incubated at 30° C. was used.

While the evening separation with the properly cleaned separator caused little or no increase in bacteria in the milk, the morning separation, after the separator had stood over night without cleaning, resulted in a marked increase.

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TABLE 1
Increase in bacteria counts due to separation. Separator used twice daily, washed only after morning separation

DATE	MORNING		EVENING	
	Before separation	After separation	Before separation	After separation
Oct. 8	1,600	2,900	5,000	6,100
9	8,800	125,000	130,000	120,000
10	6,300	390,000		
11	6,700	37,000	34,000	72,000
14	18,000	31,000	39,000	36,000
Average	8,280	117,180	49,500	58,520

This effect will vary with the temperature of the room, the time the separator is allowed to stand uncleaned, and the original condition of the milk.

Any system designed to improve the condition of farm separators and milking machines must be inexpensive and should lessen rather than increase the labor. In attempting to devise a new method of cleaning this type of equipment to meet these requirements, we have taken advantage of the well-known bactericidal action of alkaline washing powders when used in solutions having a pH of approximately 11.0 or higher. Trisodium phosphate was chosen because, while it is an excellent detergent, its corrosive action is less than that of some of the other alkalis.

A five per cent solution of trisodium phosphate has a pH of 10.9. Increasing the strength of the solution to 10 per cent produces a change in the pH of only 0.3.

The corrosive action of trisodium phosphate may be reduced by the presence of small amounts of sodium chromate,¹ sodium perborate,² alkaline sodium metasilicate,¹ and other similar substances.

The protective action of these three chemicals against the corrosive action of a five per cent solution of trisodium phosphate on tin plate is illustrated in Table 2. This test was made by cutting ordinary tin plate in strips 7/8 x 1-1/2" and submerging them in a five per cent solution of trisodium phosphate with various combinations of sodium chromate, sodium perborate, and sodium metasilicate, as shown in the Table. To be strictly comparable the comparisons should be made on the basis of surface exposed but since the strips of metal were of almost identical size the relative loss of weight is sufficiently accurate for this purpose.

¹ The use of combinations of sodium chromate, sodium silicate, and trisodium phosphate is protected by United States patents.

² Hunziker, O. F. *The Butter Industry*. Second edition. 1927, p. 58.

³ Vail, James G. Some less familiar applications of soluble silicates. *Ind. and Eng. Chem.*, 22: 1930; 972-974.

TABLE 2

Retardation of the corrosive action of trisodium phosphate on tin plate by sodium chromate, sodium perborate, and sodium metasilicate

TRIAL NO.	TRISODIUM PHOSPHATE SOLUTION CONTAINING			LOSS OF WEIGHT		
	Sodium chromate	Sodium perborate	Sodium metasilicate	7 days	14 days	21 days
	%	%	%	%	%	%
1	—			.038 (2)	.070	.147
2	0.5			.008 (2)	.018	.021
3	3.0			.000 (1)	.000	.000
4	5.0			.000 (1)	.000	.000
5		1		.018 (2)	.047	.086
6		5		.036 (2)	.057	.097
7		10		.042 (2)	.068	.099
8		20		.033 (2)	.058	.090
9			1	.041 (2)	.068	.111
10			5	.028 (2)	.044	.072
11			10	.026 (2)	.040	.080
12			20	.028 (2)	.048	.077
13	0.5	3		.008 (3)	.018	.024
14	0.5	5		.005 (3)	.009	.013
15	0.5		3	.011 (3)	.018	.023
16	0.5		5	.009 (3)	.015	.020

(1) Tin bright.

(2) Tin mottled like galvanized iron.

(3) Black patches usually beginning at the edge; remainder of tin bright.

In Table 2, Trial 1 shows the extent of corrosion by the five per cent solution of trisodium phosphate alone. When one-half of one per cent of sodium chromate was added this effect was materially reduced but not entirely eliminated; but with three and five per cent addition the loss in weight became less than one milligram in 28 days from metal weighing about 2.5 grams. Part of this loss could be accounted for by the cleansing action of the solution, but in the three per cent solution there was eventually a slight but distinct action made evident by dark spots on the tin.

Sodium perborate, sodium metasilicate, and combinations of the two had some protective action, but in none of the concentrations tried was it sufficient. It was observed that when the perborate or metasilicate was used with trisodium phosphate the corrosive action of the phosphate was evident in a mottled appearance of the tin, giving it the appearance of galvanized iron, while if one of the two was used in combination with chromate the tin remained bright except where dark patches developed.

In our experimental work a solution was used containing trisodium phosphate and sodium chromate in the following proportions:

Trisodium phosphate	5.000 grams
Sodium chromate ⁴	0.150 "
Water	100.000 "

In view of the slightly corrosive action of the three per cent solution, it would probably be advisable in practice to use a solution containing five pounds of sodium chromate in each 100 pounds of trisodium phosphate.

Rubber tubing submerged in the trisodium phosphate-chromate solution for months showed no indication of any deterioration.

The labor involved in using a cleaning solution in the usual way was reduced by omitting any washing, scrubbing, or steaming of the separator parts, and substituting a rinsing of the parts in tap water, submerging in the trisodium phosphate-chromate solution until the next separation, rinsing in water to remove the solution, and assembling the parts. With this treatment any slime or sediment adhering to the bowl is loosened and remains in the solution, leaving the metal clean in appearance and nearly free from bacteria.

Soldered joints are darkened by this solution, and if any part is not completely submerged a dark line will be formed at the surface of the liquid,

TABLE 3

Increase in bacteria counts due to separation. Separator parts kept in bisodium phosphate-chromate solution between separations

DATE	MORNING		EVENING	
	Before separation	After separation	Before separation	After separation
Oct. 15	18,000	26,000		
16	7,100	14,000	26,000	29,000
17	15,000	19,000		
18	2,300	2,700		
21	7,000	6,500	4,100	3,600
22	7,900	6,500		
23	6,700	5,300	13,000	12,000
24	3,700	4,200	3,300	3,100
25	28,000	19,000		
28	5,500	11,000	20,000	21,000
30	3,100	2,900	13,000	8,000
Nov. 1	4,600	4,200		
4	9,000	6,500	2,300	2,500
6	14,000	11,000	13,000	11,000
7	59,000	58,000	63,000	65,000
12	10,000	9,800	9,600	8,400
Average	12,556	12,912	16,730	16,360

⁴ It has been stated that some people are sensitive to sodium chromate and that a skin eruption results from its use. We have not observed this in our experience and, since it is not necessary to submerge the hands in the solution, trouble from this source would not be expected.

evidently through electrolytic action, but otherwise the appearance of the metal is unchanged. It may be advisable to occasionally scrub the separator parts with a stiff brush using a good washing powder to restore the original bright appearance.

The effect of this treatment on the bacteria count of the milk is shown in Table 3.

All factors considered, these counts show that a separator can be maintained in a satisfactory bacteriological condition by keeping the parts immersed in a solution of trisodium phosphate, while time and labor required in cleaning the separator are actually reduced.

In this experiment the separator was used twice daily and after each separation was taken down, rinsed in tap water, and submerged in the solution. At the next separation the parts were removed from the solution, rinsed in tap water, and assembled. This machine received no other treatment for the duration of the experiment.

It will be noted that in nearly every case the variation in bacteria count was well within the limits of experimental error.

MILKING MACHINES

In testing the efficiency of this system on a milking machine, a somewhat different technique was required. After each milking, the machine was rinsed in clean water and all parts, including the tubes and teat cups, but excluding the pail, were submerged in the trisodium phosphate-chromate solution. Immediately before the next milking these parts were rinsed with boiled water to remove the cleaning solution, and 2500 cc. of sterile water drawn through the machine. Bacteria counts were made on this water. In obtaining the data shown in Table 4 the machine received no other

TABLE 4
Bacteria count of rinse water from milking machine

DATE	TRISODIUM PHOSPHATE TREATMENT	CHLORINE TREATMENT	DATE	TRISODIUM PHOSPHATE TREATMENT	CHLORINE TREATMENT
July 24	1,300	14,000	Sept. 20	2,100	2,400
26	410	1,900	25	38,000	30
30	150	7,500	27	430	2,800
Aug. 20	240	5,300	Oct. 1	180	820
23	70,000	2,400	4	110	1,300
28	14,000	3,100	8	20	16,000
30	42,000	2,100	11	420	17,000
Sept. 4	4,100	7,300	15	230	14,000
6	370	1,500	18	360	30,000
10	38,000	90	22	10,000	25,000
13	1,400	1,700	25	50	17,000
17	3,000	2,000	29	80	8,300
			Nov. 1	40	9,400

treatment in the three months' period. In actual practice it would not be necessary to use boiled water if a water of good quality is available.

In the period from July 24 through August 30, the solution was not changed. It was renewed on August 30, and again on September 25. After this time it was renewed every seventh day. Examination of the solution indicated that the poor results obtained in August and September were due, not to an exhaustion of the alkali by long use, but to a gradual accumulation of bacterial spores. In October when the solution was renewed every week much lower counts were obtained than with the control chlorine treatment.

The results in the column headed "chlorine treatment" were obtained on a duplicate machine given the standard treatment used on the farm at that time.

The trisodium phosphate treatment had no apparent effect on the parts of the machine except that the handle on the top was darkened and slightly pitted. The combination used did not protect aluminum.

HOMOGENIZERS

This method has been found effective in maintaining homogenizers in a satisfactory condition. The machine should be cleaned by pumping lukewarm water through it to remove as much as possible of the milk or cream. It is then filled with the trisodium phosphate-chromate solution, the valves closed, and allowed to stand until it is used again. The solution is then drained out and the machine thoroughly flushed with hot water.

FACTORS AFFECTING THE ACTIVATABILITY¹ OF MILK WITH ULTRA-VIOLET LIGHT

W. E. KRAUSS, R. M. BETHKE, AND R. G. WASHBURN

Departments of Dairy and Animal Industry, Ohio Experiment Station, Wooster, Ohio

Supplee and coworkers (1-6) have made extensive and carefully controlled studies of the effect of various technical features of the irradiation process that might affect the ultimate vitamin D potency of milk. They have also investigated the influence of certain milk constituents, such as cholesterol and the percentage of fat, on activatability (7, 8).

It was our object to study activatability from the standpoint of factors that might be effective before the milk had reached the irradiation point. Breed, feed, and fat percentage were the factors studied. It was hoped that the data obtained would yield information as to the necessity for varying the conditions of irradiation to meet the peculiarities of milk production in a particular area. In spite of the fact that standardization of milk to a definite fat percentage is practiced to a considerable degree studies on the effect of fat percentage were included because of the association of vitamin D with fat.

PROCEDURE

The apparatus used in the irradiation process consisted of a carbon arc lamp² provided with a reflector which insured uniform distribution of the light on a thin film of milk flowing over one face of a small surface cooler having a total surface area of 3820 sq. cm. (59×65). The lamp was equipped with Industrial C carbons and was operated at approximately 50 volts and 60 amperes. The rate of flow of milk over the cooler, and consequently the thickness of the film, was determined by measuring at frequent intervals the volume of milk coming from the spout of the cooler in a given length of time and was maintained constant by adjusting a valve leading from the reservoir over the cooler and a valve leading from the milk source to the milk pump.³ A recording ammeter made a visible continuous record of the amperage output and was supplemented by almost continuous observation of the ammeter in the control cabinet during the operation of the lamp.

By determining with a stop-watch the time required for a dye to traverse the cooler it was calculated that when the rate of flow was about 1000 cc. per minute the thickness of the film was 0.12 mm. Supplee and Dorcas (4) have shown that 95 per cent or more of the incident radiation below about

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¹ By "activatability" of milk is meant the degree to which a given sample of milk becomes enriched with vitamin D when exposed to definite conditions of irradiation with ultra-violet light.

² Courtesy of the National Carbon Company, Cleveland, Ohio.

³ Courtesy of the Creamery Package Manufacturing Co., Chicago, Illinois.

2850 Å is absorbed by the first 0.11 mm. depth. Since 960 cc. was the slowest rate of flow used it can be assumed that at least 95 per cent of the incident radiation was absorbed.

It should be pointed out, however, that in the work reported in this paper absolute measurements were superfluous; it was necessary only to maintain constant conditions when a particular set of samples was prepared. This was accomplished by treating the samples exactly alike up to the point of irradiation and by having the rate of flow, the distance from the arc, and the amperage output as nearly alike as physically possible for the immediate samples to be compared.

All the samples of milk used came from cows in the Experiment Station herd. This made it possible to control the feeding as desired and made available complete histories of the treatment, feeding, and production records of the animals. As a rule the samples represented the entire production of one or more cows over periods ranging from one to five days, depending on how much milk was needed. The amount of butterfat in the milk was determined. Standardized milk samples were prepared on the basis of the fat content of the cream and skimmilk. The percentage of fat in the standardized samples was also obtained.

To determine the relative vitamin D potencies the standard line test procedure with rats was followed. The test material was fed for 8 days and the rats were killed on the eleventh day, Steenbock and Black's rickets-producing ration 2965 being fed throughout.

In order to hold the samples in good condition for the length of time required in making the line test 6 to 8 drops of 40% formalin were added per quart; in a few instances the milk was dried before fans in a drying chamber. When dried milk was assayed at a high level it was incorporated with such a quantity of the basal ration as it was estimated would be consumed in five days; at low levels the assays were conducted as with liquid milk.

RESULTS

Effect of Fat Percentage

Three separate series were run on milks standardized to different fat percentages, using skimmilk and cream from an original sample of whole milk in each series. In Series I the milk came from three Holstein cows receiving a good winter ration. In Series II and III pooled milk from Jerseys and Holsteins was used, some of the milk in Series II coming from cows on pasture. All the milk in Series III was produced under winter feeding conditions. Details concerning the samples and the results of the line test are given in Table 1.

The standard winter ration of the Experiment Station dairy herd, from which all samples were obtained, consists of alfalfa hay, corn silage, corn, oats, bran, and linseed oilmeal, the grain being fed according to production.

TABLE 1
Effect of fat percentage on activatability of milk

CHARACTERISTICS OF SAMPLE		CONDITIONS OF IRRADIATION			CONDITIONS OF ASSAY		
No.	% Fat	Distance of arc from milk (inches)	Amperage	Rate of flow (cc./min.)	No of rats	Total milk Fed (cc.)	Line test*
Series I							
73a	1.90	20	60	960	5	16.0	0.90
					6	24.0	1.25
74a	5.85	20	60	960	6	16.0	1.83
					6	24.0	2.67
75a	0.025	20	60	960	5	40.0	0.40
	(skimmilk)				4	80.0	2.00
Series II							
115x	0.03		Unir-radiated		9	64.0	0.20
	(skimmilk)						
115a	0.03	20	58	1380	9	64.0	0.56
	(skimmilk)						
115b	0.03	20	56	1860	9	64.0	0.61
	(skimmilk)						
116a	3.30	20	55	1380	9	16.0	0.79
117a	5.90	20	57.5	1200	9	16.0	1.40
117a	5.90	20	55	1800	9	16.0	1.30
Series III							
119a	0.025	22	58	1125	8	64.0	0.20
	(skimmilk)						
120a	1.50	22	58	1120	8	24.0	0.20
121a	3.20	22	57.5	1110	7	20.0	0.36
122a	6.30	22	57	1130	6	20.0	1.10

* 1.00 equals unit healing (approximately 3.0 International Units).

When on regular pasture (mixed grasses) reduced quantities of the same grain mixture are fed.

The data show that in each series as the fat percentage increased the ability of the milk to become activated increased. This observation is more or less in agreement with that of Supplee, Flanigan, Bender, and Dorcas (7) who state that "the fat content does influence to a certain but limited degree the rate at which the antirachitic properties are imparted to the milk" but whose data show that under the same conditions of irradiation the vitamin D per cc. of milk increased as the fat percentage increased, levels of 0.6%, 1.2%, and 3.6% fat being used. The next level used by these investigators was 7.2% fat, at which point the vitamin D potency was no greater than at 3.6% fat under the same conditions of irradiation. Our data show a distinct increase in the potency of 6.3% milk over 3.2% milk. Supplee *et al.* also state

that "the *maximum*⁴ antirachitic activity of milk resulting from direct irradiation does not parallel the fat content." It should be pointed out that this statement and our data are not contradictory since we were not concerned with maximum potencies.

EFFECT OF FEED

Winter Feeding vs. Pasture Feeding.—In a preliminary trial (Table 2, Series I) a sample of winter milk from one cow was compared with a pooled sample of pasture milk, both samples having approximately the same fat percentage. Although the unirradiated pasture milk was considerably more potent than the unirradiated winter milk, after irradiation the potencies of the two milks were approximately the same.

More significant data were obtained by collecting milk from the same cows while on winter feed and after they had access to spring bluegrass pasture for two weeks. The samples were dried so that they could be assayed simultaneously. This series also included a sample of milk from cows pasturing on wheat. The results (Table 2, Series II) indicate that irradiated pasture milks are slightly more potent than irradiated winter milks. Since the unirradiated pasture milks were more potent than the unirradiated winter milks it is probable that the original potencies were reflected in the irradiated milks. The evidence does not indicate the presence in pasture milks of any more activatable material than is present in winter milk.

High Protein Grain vs. Low Protein Grain.—Since there were available cows that had been fed for a long time on rations that were extremely low or extremely high in protein it was thought of interest to include the milk from these cows in this study. The rations differed not only in the amount of protein they furnished but in the vitamin D-carrying components as well. Alfalfa hay and a small amount of corn silage constituted the roughage of the high protein group, while timothy hay and a liberal quantity of corn silage made up the roughage of the low protein group. From Table 2, Series III, it will be seen that untreated milk from the high protein cows contained more vitamin D than untreated milk from the low protein cows. This undoubtedly was due to a greater intake of vitamin D from the alfalfa than from the timothy. After irradiation the milk from the high protein cows was more potent, reflecting again the original potencies of the untreated milks.

A.I.V. Silage vs. Alfalfa Hay.—One group of cows was fed alfalfa hay and one group A.I.V. (mineral acid treated) silage as the only roughage, the rest of the ration being the same for both groups. That the untreated milk from the A.I.V. cows was less potent than that from the alfalfa cows could have been anticipated because much more vitamin D had been found in the hay than in the A.I.V. silage. This relationship existed after irradiation (Table 2, Series IV). Because no positive line test response was obtained

⁴ Authors' italics.

TABLE 2
Effect of feed on activatability of milk

CHARACTERISTICS OF SAMPLE			CONDITIONS OF IRRADIATION			CONDITIONS OF ASSAY		
No.	% Fat	Source	Distance of arc from milk (inches)	Amperage	Rate of flow (cc/min)	No of rats	Total milk fed	Line test*
Series I								
97a	3.65	Winter feeding		Unirradiated		8	120 cc	1.56
98a	3.65	"	20	60	1050	8	16 cc	1.70
99a	3.70	Pasture feeding		Unirradiated		8	120 cc	2.90
100a	3.70	"	20	60	1050	8	16 cc.	1.56
Series II								
109b†	4.00	Winter feeding		Unirradiated		6	12 gm.	0.33
109a†	4.00	"	20	59	1320	8	200 mg.	0.30
118a†	4.00	Pasture feeding		Unirradiated		8	300 mg.	0.90
		Same cows as 109b				6	12 gm.	1.30
118b†	4.00	"	20	56	1320	7	200 mg.	0.60
114b†	4.30	Pasture feeding (Green wheat)		Unirradiated		7	300 mg.	1.00
		"	20	60	1296	6	12 gm.	1.20
114a†	4.30	"				8	200 mg.	0.94
		"				7	300 mg.	1.43

TABLE 2—(Continued)

CHARACTERISTICS OF SAMPLE			CONDITIONS OF IRRADIATION			CONDITIONS OF ASSAY		
No.	% Fat	Source	Distance of arc from milk (inches)	Amperage	Rate of flow (cc./min.)	No of rats	Total milk fed	Line test*
Series III								
123a	3.40	Cows fed high protein ration		Unirradiated		5	100 cc.	1.80
123b	3.40	" " "	20	60	1116	7	20 cc.	0.43
124a	3.20	Cows fed low protein ration		Unirradiated		5	100 cc.	0.40
124b	3.20	" " "	20*	55	1110	7	20 cc.	0.00
Series IV								
125a	3.95	Cows fed alfalfa as sole roughage		Unirradiated		7	80 cc.	0.57
125b	3.95	" " " "	20	57	1122	8	12 cc.	0.20
126a	4.05	Cows fed A.I.V. as sole roughage		Unirradiated		8	16.8 cc.	0.94
126b	4.05	" " " "	20	57	1140	7	80 cc.	0.21
127b	4.10	Cows fed alfalfa as sole roughage	20	57	1068	8	12 cc.	0.00
128b	4.05	Cows fed A.I.V. as sole roughage	20	57	1104	8	16.8 cc.	0.00
			20	57		7	20.0 cc.	2.90
						7	20.0 cc.	2.00

* 1.00 equals unit healing (approximately 3.0 International Units).

† Dried.

when irradiated A.I.V. milk was fed at 12.0 and 16.8 cc. levels the trial was repeated at a higher level on freshly collected batches of both milks, with the same results. The much greater line test response obtained on both irradiated milks after increasing the level of feeding but slightly might be attributed to the fact that new carbons were used in the lamp. This was the only change made so far as we are aware. The well-known variation in response of different groups of rats might also have exerted some influence.

So far as effect of feed is concerned, then, it seems that when the fat percentage is approximately constant the chief factor determining the vitamin D potency of milks irradiated under comparable conditions is the original potency of the unirradiated milks.

EFFECT OF BREED

Holstein milk and Jersey milk from cows on the same ration were separated and then standardized to 3.5% fat with the respective creams and skim-milks. Part of the standardized milks was irradiated and both unirradiated and irradiated samples were assayed for vitamin D. The standardized milks from both breeds had approximately the same vitamin D potency before and after irradiation (Table 3, Series I). If anything, the Jersey milk was slightly more potent before irradiation and the Holstein milk was slightly more potent after irradiation.

The next step consisted of assaying unstandardized Jersey and Holstein milks before and after irradiation (Table 3, Series II). In this case the unirradiated Jersey milk was definitely more potent than the Holstein unirradiated milk but after irradiation both milks had the same potency. A repetition of this trial yielded the same results (Table 3, Series III).

Previously (Table 1) it had been shown that milks containing 5.9% and 6.3% fat, respectively, were more potent after irradiating than milks containing 3.3% and 3.2% fat, respectively. The samples represented pooled milk from a mixed herd of Jerseys and Holsteins. In view of the results obtained with the breed milks (Table 3), the possibility is suggested that Holstein milk contains in the solids-not-fat fraction more activatable material than does Jersey milk.

DISCUSSION

The data presented lend support to the contention that in commercial irradiation of milk standardized to a definite fat percentage, milk of the desired vitamin D potency will be obtained so long as the conditions of irradiation are established on milk which was produced toward the end of the winter feeding period when its natural vitamin D potency was lowest. After the conditions of irradiation have been established on such milk the usual variation in the processes that influence the characteristics of milk up to the point of irradiation would probably be of insufficient magnitude to cause the milk to drop below the minimum required potency.

TABLE 3
Effect of breed on actvatability of milk

CHARACTERISTICS OF SAMPLE			CONDITIONS OF IRRADIATION			CONDITIONS OF ASSAY		
No	% Fat	Source	Distance of arc from milk (inches)	Amperage	Rate of flow (cc./min.)	No. of rats	Total milk fed (cc.)	Line test*
Series I								
129a	3.5	Holstein milk (standardized)		Unirradiated		7	80.0	0.36
129b	3.5	" "	20	57	1080	9	16.8	0.39
130a	3.5	Jersey milk (standardized)		Unirradiated		7	80.0	0.50
130b	3.5	" "	20	57	1074	9	16.8	0.28
Series II								
131a	3.15	Holstein milk		Unirradiated		7	100.0	0.70
131b	3.15	" "	18	55	1080	7	20.0	2.40
132a	5.25	Jersey milk		Unirradiated		7	100.0	1.60
132b	5.25	" "	18	54	1074	7	20.0	2.30
Series III								
133a	3.25	Holstein milk		Unirradiated		8	80.0	0.50
133b	3.25	" "	20	57	1248	7	16.0	1.14
134a	5.40	Jersey milk		Unirradiated		8	80.0	0.75
134b	5.40	" "	20	57	1218	9	16.0	1.17

* 1.00 equals unit healing (approximately 3.0 International Units).

SUMMARY

Information was obtained as to the extent to which fat percentage, breed, and feed affected the ultimate vitamin D potency (activatability) of milk subjected to the same conditions of irradiation with ultra-violet light.

In general, as the fat percentage of the milk increased the activatability increased.

When the fat percentage is approximately constant the chief factor determining the vitamin D potency of milks irradiated under comparable conditions is the original potency of the unirradiated milks. This was determined by studying the activatability of milks produced under widely different systems of feeding in which the type of roughage was the principal variant.

Holstein and Jersey milks standardized to the same fat percentage were activated to the same degree on irradiation. Unstandardized milks from the same breeds were also activated to the same degree even though the Jersey milk contained appreciably more fat and possessed greater original vitamin D potency. This suggests that the solids-not-fat fraction of Holstein milk may contain more activatable material than that of Jersey milk.

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THE "TRANSITION POINT" OF MILK FAT

G. A. RICHARDSON

University of California, Branch of College of Agriculture, Davis, California

If milk fat is an alloy-like mixture, then the cooling curve of a molten milk fat should show a definite break with the appearance of a second phase. Horn and Osol (1) in the case of cacao butter, using a cooling medium of melting ice, reported supercooling with a subsequent rise in temperature to a definite maximum. This maximum temperature they called the transition point. Horn and Wilson (2) later used this method to determine the degree of adulteration of cacao butter with milk fat.

In attempting to employ the above method to obtain a cooling curve for milk fat, it became apparent that the "transition point" was several degrees lower than the temperature where the second phase appeared as shown by visible turbidity. This was also apparent when the cooling medium was at a temperature of 20° C. It became evident, therefore, that if the transition point was to approximate the temperature of the appearance of the second phase, a much slower rate of cooling was necessary.

The following technique proved satisfactory. Thirty-five grams of melted fat at a temperature of 40–45° C. are carefully introduced into a pyrex, silvered, evacuated Dewar tube, 8 inches in length and 1 inch in diameter inside dimensions. This tube is fitted with a rubber stopper through which passes a thermometer graduated in 1/10 degrees, the bulb of which extends well down into the fat. The tube is also fitted with a small glass stirrer, the shaft passing through the stopper and the hollow circular base being such that it is free to move vertically without touching the sides of the tube or thermometer within it. The tube thus fitted is suspended in a water bath, the temperature of which may be regularly and progressively raised or lowered, or maintained constant, according to the desires of the operator. This temperature control within the temperature range here employed is very satisfactorily attained by the use of an adjustable-level water reservoir and a knife-edge 500 Watt heater in a closed circuit with the reservoir and the bath.

By maintaining a sufficiently small temperature gradient between the fat and the bath, very slow cooling is effected. Stirring should be restricted to not more than one up and down stroke per minute. During the initial cooling period the temperature may be read every five minutes, but as the temperature of the fat approaches the melting point reading should be taken every minute.

As long as the constant temperature gradient is maintained and the system consists of a single liquid phase, the rate of cooling remains uniform.

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As soon as a second phase appears, the rate of cooling becomes irregular, growing less and less until cooling ceases. The separation of the second phase is usually so slow that even with a small temperature gradient a certain amount of supercooling takes place. As the separation becomes sufficiently rapid the temperature rises to a maximum. At this point—the so-called transition point—the temperature remains constant, within 0.01°C ., for a period often as long as 30 minutes, even with a temperature gradient as large as one degree. This period is followed by a slow lowering of the temperature. The fat at this stage has the appearance of crystals suspended in a clear liquid. Duplicate determinations may be expected to correspond within 0.01 degree. No greater variation than 0.05 degree should be accepted.

The resulting time-temperature curves for a few samples of milk fat are shown in figure 1. These fats differ with respect not only to the transition points but also to the entire transition periods. They illustrate a variation which may be expected to exist between milk fats which have been secreted by cows subjected to a varying feeding regime. Curve U. F. represents a fat produced by a herd under spring feeding conditions, while curve X represents a fat produced under a dry feeding regime. Curves 4-323, 10-323, 12-323, 16-323, 26-323 and 28-323 represent a series of fats produced by cow 323 of the Station herd on the dates surrounding October 13, October 26, November 2, November 16, December 15 and January 12, respectively. Cow 323 was 8 years old and began the fifth month of her lactation period on October 9. On October 13 she was fed a ration of concentrate, corn silage, green alfalfa and pasture. Curve 4-323 is the cooling curve of the fat at that date. No. 10 fat was obtained immediately following the time when alfalfa hay was substituted for the remainder of the ration. For No. 12 fat the cow was supposedly on the ration of alfalfa hay, but investigation revealed her to have had access to green feed the preceding day. Curves 16 and 26 represent fats obtained while the cow was still on the ration restricted to alfalfa hay. On December 22 corn silage was added to the ration. Curve 28-323 represents the fat after an interval of about 3 weeks.

Special mention should be made of curve R. This fat was produced by a cow which was establishing a world's record for fat production in her class. The fat yield was out of proportion to the feed consumed. Chemical analyses of this fat, as well as the physical condition of the cow indicated that body fat was being utilized in the production of milk fat. At 37.5° the fat was clear, while at 36.4° a turbidity was visible. This latter increased as the temperature was gradually lowered. The appearance of turbidity coincided almost exactly with the first change in the direction of the curve. No supercooling with subsequent rise to a maximum took place. Unfortunately, not sufficient of this fat was available to permit a thermal study at higher temperatures.

In contrast to milk fat, the cooling curve of a sample of a nut margarine was smooth and regular to a temperature of 22.5° C., when a second phase appeared, supercooling took place and this was followed by an increase in temperature to a maximum of 23.10° C. which persisted for 30-35 minutes.

DISCUSSION

Although Arup (3) subjected milk fat to fractional crystallization and analyzed fractions which separated at 37°, 27°, 20°, 15° C., as well as those which were liquid at 15 and 10° C., yet milk fat has not been subjected to extensive thermal analysis. Rahn (4) has shown that the congealing point of milk fat varies with the temperature of the cooling bath. His cooling curves from progressive cooling showed a maximum rise in temperature at the congealing point (22.5-24° C.) with a fairly smooth curve down to 12-14° C. The nature of the cooling curves of samples of cacao butter has been reported by Pichard (5) and by Straub and Malotau (6). Each observed typical supercooling with a rise to a maximum which was called the setting or congealing point. The "transition point" of Horn and Osol (1) was several degrees higher for cacao butter than the "setting point" of Pichard, Straub and Malotau.

Theoretically the temperatures of complete fusion and incipient solidification should coincide. In other words, fusion and solidification are two reciprocal and reversible phenomena. In the case of végétaline and stearine Chatelier and Cavaignac (7) confirmed such a reversibility but pointed out that the point of fusion approaches much nearer than the point of solidification to the exact temperature of the change of state. This latter may be accounted for on the assumption that supercooling is more prevalent than superheating.

Milk fat is a somewhat more highly complex alloy-like system than the natural vegetable fats. Consequently, a more highly refined technique than that used by Chatelier and Cavaignac is essential to confirm the reversibility. In figure 1 the values for melting points and transition points differ by 1.3 to 3.7 degrees. These differences should not be interpreted to mean that the temperatures of complete fusion and incipient solidification are not coincident. In making melting point determinations of milk fat by the Wiley method the author has considerable difficulty in determining when the disc of fat has assumed a spherical shape and has become definitely clear. With some milk fats it often happens that a difference of as much as two or three degrees lies between the temperature when the fat appears practically clear and the temperature when it may be judged absolutely clear. In the case of cacao butter, Horn and Osol (1) found as great a difference as 6° between the temperatures of incipient fusion and complete fusion. These considerations together with the acknowledgment that the melting point values were secured for the purpose of comparison between the fats rather than for precision purposes permit of the assumption that the transition

TRANSITION POINTS OF SOME MILK FATS

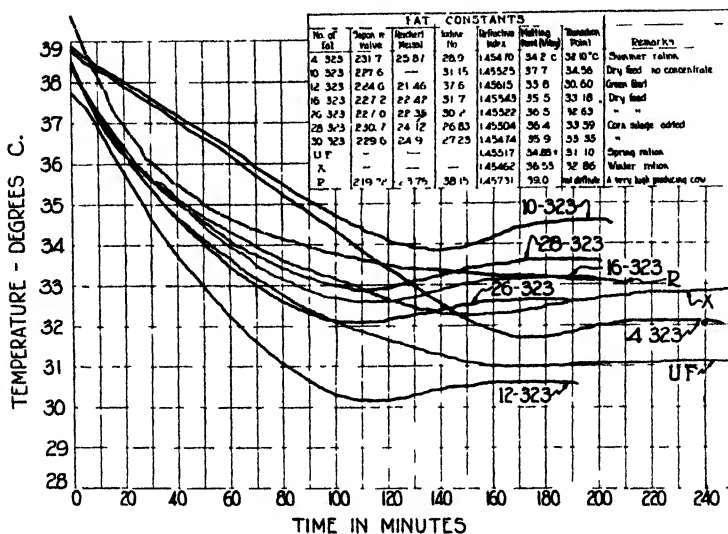


FIGURE 1.

point determined by this refined technique represents a temperature more nearly coincident with the true fusion temperature than does the melting point by the methods generally accepted. Its precision compensates for its tediousness.

CONCLUSIONS

1. The cooling curve of milk yields an insight into the physical and chemical nature of the fat.
2. The "transition point" when determined by the modified technique represents a temperature where a second phase begins to separate from a molten fat.

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OXIDIZED FLAVOR IN MILK

III. THE TIME OF COPPER CONTAMINATION DURING PRODUCTION AND PROCESSING, AND AERATION VERSUS NO AERATION AS RELATED TO OXIDIZED FLAVOR DEVELOPMENT*

W. CARSON BROWN,¹ L. M. THURSTON,¹ AND R. B. DUSTMAN²

West Virginia Agricultural Experiment Station, Morgantown

Various investigators have studied conditions necessary for the development of oxidized flavor, but little attention has been directed to the relationship between the time of contamination with copper and the pasteurizing process. Likewise little is known concerning the effects of surface and internal cooling on the development of oxidized flavor in milk.

In order to determine whether pasteurization has any effect on the development of oxidized flavor in milk it was decided to study this factor by the use of specially constructed glass pasteurizing and cooling equipment, in which milk could be handled under conditions similar to those obtaining in milk-pasteurizing plants, with the exception that no metallic contamination of the milk by the equipment would be possible.

EQUIPMENT

The glass pasteurizing equipment consisted of a five-liter round-bottom flask held in position in a water bath by means of a suitable clamp. A motor-driven agitator, made of glass, was operated in the milk at such a speed as to cause gentle agitation of the milk. The speed of the agitator was controlled by operating it on a belt from a motor with a variable speed drive through a reduction pulley. A second agitator, operated in the water bath, served to bring about a uniform distribution of heat throughout the water bath. The water bath was heated by means of flowing steam and the level of the water in the bath was controlled by the introduction of water through a rubber hose from a tap, and by removal through a siphon. Thermometers suitably clamped in position served as guides for the manual control of the temperature of the milk. With these arrangements, and with the constant attention of one person, the pasteurizing temperature could be controlled within one degree of that desired. Figure 1 illustrates this assembly.

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¹ Department of Dairy Husbandry.

² Department of Agricultural Chemistry.

The data presented herein are to be included in a thesis by W. Carson Brown in partial fulfillment of the requirements for the degree of Doctor of Philosophy, West Virginia University.

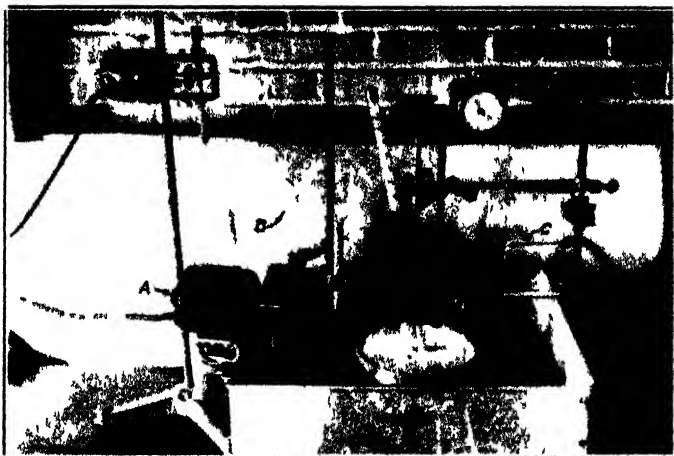


FIG. 1. EQUIPMENT USED FOR PASTEURIZING MILK IN GLASS

A, motor-driven water agitator; B, siphon for controlling water level, C, steam inlet Purpose of other equipment is obvious.

The glass cooling equipment consisted of two units, one for surface cooling and the other for internal cooling. Both units were mounted on a specially constructed stand as illustrated in Figure 2. The equipment for internal cooling consisted of a condenser 30 inches long with the inner tube similar to Vigreux distilling tube. Ice water from an elevated ice cream packing tub, which was charged with ice and water, served as the cooling medium. When used as a cooler the condenser was filled with milk and a volume of the milk equal to the capacity of the condenser was withdrawn while keeping the condenser filled with milk before experimental samples were taken. In this way exposure of the milk to air was kept at a minimum for the equipment used.

The equipment for surface cooling consisted of a series of 21 glass tubes (10 mm. diameter), bent upward at an angle from points near each end, and fastened into a wooden frame. The bends in the tubes served to prevent any flow of milk against the wooden frame. Alternating with each tube in the frame was a piece of flat window glass two inches wide through its center and tapered at the ends to fit the bends in the tube below it. The flat glass served to increase the aerating surface and also to aid in directing the flow of milk over each tube. The upper 11 tubes of the cooler were connected with rubber tubes. Tap water, circulated through these tubes from bottom to top served as the cooling medium. The lower ten tubes also were connected with rubber tubes, and ice water from the elevated ice cream packing tub was circulated through this section of the cooler. The total length of this cooler was about

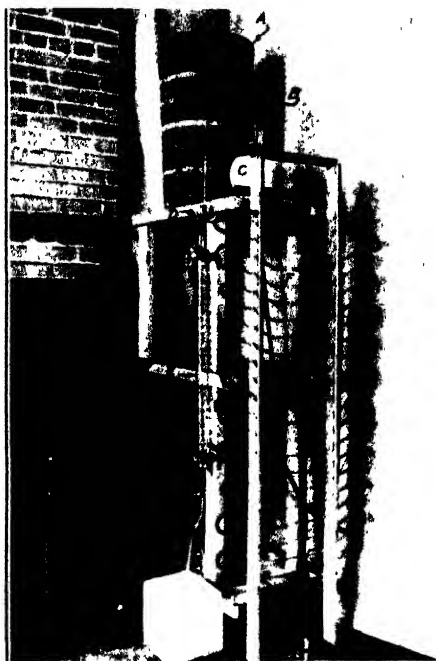


FIG. 2. EQUIPMENT USED FOR COOLING MILK IN CONTACT WITH GLASS

A, Ice cream tub containing ice and water; B, siphon; C, flask containing hot milk; D, three-way stopcock; E, internal cooler; F, surface cooler.

4.5 feet. Milk was delivered to the cooler through a removable glass tube fire-sealed at one end and having a series of small holes in its upper surface.

When preparing to cool milk a special glass siphon was placed in the flask containing the hot, pasteurized milk and the flask then was clamped into position on the wooden frame above the two coolers. The siphon was equipped with a three-way stopcock so that milk could be delivered either to the surface cooler or to the internal cooler.

Other equipment used in this work does not require description.

EXPERIMENTAL

Experiments Using the Special Glass Equipment

All the milk used in these experiments was from cows selected because their milk was known to be susceptible to oxidized flavor development. The milk was drawn into aluminum pails and poured directly into aluminum cans, omitting the usual straining operation because the strainers available at the time this work was done exposed copper surfaces which came in contact

with the milk that was passed through them. The milk was brought to the laboratory immediately and cooled by immersing the cans in ice water.

Samples of the raw milk in pint milk bottles were prepared containing 0.5, 1.0, 1.5, 2.0, and 2.5 parts per million of added copper,³ respectively. One sample to which no copper was added served as a control in each trial. The remaining milk, in each trial, was used in studies of the effect of pasteurization. Each pasteurization was carried out at $143^{\circ}\text{F} \pm 1^{\circ}$ for 30 minutes. Before being used the surface cooler was washed with alkaline solution and rinsed with distilled water. Pasteurizations in this experiment were carried out in two series, one in which copper was added before pasteurization, and the other in which copper was added after pasteurization and cooling. The amounts of copper added in each series were the same as those used in the raw milk, previously detailed, and part of each milk in each series was surface-cooled, whereas the remainder was cooled internally. The milk usually was at a temperature of 50 to 55°F . after internal- or surface-cooling, and accordingly all samples were immersed in ice water for several hours as soon as they were prepared.

To avoid, in so far as possible, any effect that light might have during processing and storage, all pasteurizing and sampling operations were carried out at night under illumination from red light-bulbs, and the individual samples in pint milk bottles, when removed from the ice water, were placed in brown paper bags during storage for three days at approximately 40°F . At the end of the three-day storage period the samples were tasted and the intensity of the oxidized flavor was recorded.

The results of this study are recorded in tables 1 and 2. Table 1 shows a comparison of the effects of internal and surface cooling, and table 2 shows the effects of adding copper before pasteurization as compared to adding it after pasteurization.

Studies With the Milk of Individual Cows

The results recorded in table 2 indicate that there is a decided, though not entirely consistent, tendency for oxidized flavor to develop more readily, and to a greater intensity, in milks to which copper was added after pasteurization than in milks to which copper was added before pasteurization. In order to obtain further information on this point the milk from each cow in the Experiment Station herd was studied individually. The milk was drawn into aluminum buckets and several pint milk bottles were filled immediately with the milk of each cow. Raw-milk samples, with and without added copper, were stored for three days at 40°F . before tasting. The re-

³ Copper sulphate solution was added. In preparing the solution crystals were brushed free of any anhydrous salt that may have been present, and the solution was made up to a strength such that not more than 2.5 ml. was required in a pint of milk to make the added copper amount to 2.5 parts per million.

TABLE 1

Comparison of internal cooling with surface cooling of milk in relation to development of oxidized flavor. (Copper added after pasteurization)

TREATMENT	COPPER ADDED PPM.	TRIAL NUMBER				AVERAGE INTENSITY
		I	II	III	IV	
Internal Cooling	None	—*	—	—	—	—
	0.5	1	1	3	2	1.75
	1.0	2	2	4	2 to 3	2.63
	1.5	3	2	3	3 to 4	2.88
	2.0	3	2	3	4	3.0
	2.5	3	2	3 to 4	3	2.88
Surface Cooling	None	—	—	—	—	—
	0.5	1	1	3	3	2.0
	1.0	1	2	3	2 to 3	2.13
	1.5	2	4	3	lost	3.0
	2.0	1	4	4	4	3.25
	2.5	2	4	4	3	3.25

* Meaning of symbols: —, no oxidized flavor; ?, may or may not have been oxidized; 1, very slight oxidized flavor; 2, slight oxidized flavor; 3, moderate oxidized flavor; 4, fairly pronounced oxidized flavor; 5, pronounced oxidized flavor; and 6, very pronounced oxidized flavor.

TABLE 2

Relation of incidence of contamination with Cu to the development of oxidized flavor in raw and pasteurized milk

TREATMENT	COPPER ADDED PPM.	TRIAL NUMBER				AVERAGE INTENSITY
		I	II	III	IV	
Raw milk	None	—	—	—	—	—
	0.5	1	1	3 to 4	2	1.88
	1.0	3	1	3	3	2.50
	1.5	3	2	3	2	2.50
	2.0	3	2	3 to 4	2 to 3	2.75
	2.5	4	3	4	3	3.50
Pasteurized in glass container (Copper added <i>before</i> pas- teurizing)	None	—	—	—	—	—
	0.5	?	?	1	2	0.75
	1.0	?	?	?	1	0.25
	1.5	?	?	?	1	0.25
	2.0	?	?	1	2	0.75
	2.5	Missed	?	1	3	1.00
Pasteurized in glass container (Copper added <i>after</i> pas- teurizing)	None	—	—	—	—	—
	0.5	1	1	3	2	1.75
	1.0	2	2	4	2 to 3	2.63
	1.5	3	2	3	3 to 4	2.88
	2.0	3	2	3	4	3.00
	2.5	3	2	3 to 4	3	2.88

For meaning of symbols in above table see footnotes, Table 1.

TABLE 3

The relation of pasteurization and of the addition of copper before or after pasteurization to the subsequent development of oxidized flavor in the milks of individual cows. Copper added to all milks at the rate of 1.3 p.p.m.

DATE	TOTAL NUMBER OF COWS TESTED	RAW MILKS HAVING OXIDIZED FLAVOR WITH ADDED COPPER		PASTEURIZED MILKS HAVING OXIDIZED FLAVOR			
				Copper added before pasteurization		Copper added after pasteurization	
		Number of cows	Per cent of cows tested	Number of cows	Per cent of cows tested	Number of cows	Per cent of cows tested
4/ 6/36	44	16	36.4	8	18.2	26	59.1
4/12/36	44	10	22.7	2	4.5	19	43.2
4/20/36	40	15	37.5	9	22.5	26	65.0

TABLE 4

The effects of the addition of 1.3 parts per million of copper before and after pasteurization to samples of the milks of individual cows. (Samples taken 4/20/36)

COW NO.	NO COPPER ADDED	COPPER ADDED before PASTEURIZATION	COPPER ADDED after PASTEURIZATION
176	—	—	3
305	—	1	2
319	—	—	1
321	—	1	3
326	—	2	2
332	—	—	2
336	—	2	3
347	—	—	2
358	—	2	2
359	—	—	1
360	—	—	3
361	—	—	3
362	—	2	3
363	—	—	3
366	—	—	2
367	—	—	1
368	—	—	2
369	—	—	†
373	—	2	2
381	—	—	2
388	—	1	3
389	—	—	3
390	—	3	3
391	—	—	1
392	—	—	2
395	—	—	2
398	—	—	1
405	—	—	†

* Records of all cows producing milk that was not susceptible to oxidized flavor development were omitted from table. For meaning of symbols see Table 1, footnotes.

maining samples were pasteurized for 30 minutes at as near 143° F. as possible by immersion in a hot water bath, one sample from each cow having copper added to it before pasteurization and another afterward. The samples were cooled, then stored and tasted along with the raw-milk samples. All additions of copper in this experiment were at the rate of 1.3 parts per million. The experiment was repeated twice.

A summary of the results of these experiments is shown in table 3, and a detailed tabulation of the results of one of the experiments is recorded in table 4.

DISCUSSION

Surface cooling with the resulting exposure of the milk in a thin film to the air might be expected to favor the development of oxidized flavor, especially as compared to internal cooling. This appears not to be the case as shown by these experiments. It would appear from these results that only surface coolers from which the milk may dissolve copper would be likely to contribute to oxidized flavor development.

So far as the authors are aware, it has not been observed previously that contamination of susceptible milk with copper *after* pasteurization tends to cause a more pronounced development of oxidized flavor than does contamination with copper *before* pasteurization. This effect seems to obtain as shown by the experiments herein reported.

The effect on oxidized flavor development of the time of copper addition or contamination in relation to the time of pasteurization has both a practical and an experimental application. From a practical standpoint it would appear that the prevention of contamination of pasteurized milk with copper in the milk plant is of greater importance than the prevention of copper contamination of raw milk at the farm. It would seem also that slight contamination of the milk with copper at the farm would not result in the production of an oxidized flavor sufficiently intense to be objected to by many customers buying the milk after it has been pasteurized, provided no contamination with copper occurred during processing in the pasteurizing plant. However, no data on the effects of excessive copper contamination were obtained. From an experimental standpoint, in testing the susceptibility of milk to oxidized flavor development by adding known amounts of copper, more reliable results may be expected with raw milk or with pasteurized milk to which the copper has been added *after* pasteurization than with pasteurized milk to which the copper has been added *before* pasteurization.

At the present time there appears to be no satisfactory explanation for the effect of the time of adding copper in relation to the time of pasteurization on the development of oxidized flavor.

In this study comparisons of the development of oxidized flavor in pasteurized milk with that in raw milk do not yield entirely consistent results.

In table 2 the intensities of oxidized flavor developed in the raw milks in the four trials average almost exactly the same as the intensities for the pasteurized milks to which the copper was added *after* pasteurization. Results shown in table 3 are tabulated in terms of frequency of the occurrence of oxidized flavor rather than of intensity of this flavor, but the fact that in these results the flavor occurred less frequently in the raw milks than in the corresponding milks to which the copper was added *after* pasteurization would indicate that pasteurized milk is more susceptible to oxidized flavor development than raw milk. Of course it must be kept in mind that the results in table 3 are for the milks of individual cows whereas the results in table 2 are for mixed milks, and also that pasteurization and cooling of milks studied in connection with the results in table 3 were carried out by the in-the-bottle method whereas batch pasteurization and separate cooling were employed in the case of milks studied in connection with the results in table 2. However, these facts do not offer any explanation of the effects observed. It would seem that the only observation that should be made on this point at present is that when amounts of copper ranging up to 2.5 parts per million are added to susceptible milk the intensity of the resulting oxidized flavor may be expected to be greater in the raw milk than in the corresponding pasteurized milk when the copper contamination occurs *before* pasteurization, but may be expected to be about the same as that of the raw milk when the copper contamination occurs *after* pasteurization.

CONCLUSIONS

When pasteurization is carried out by the so-called low-long method contamination of the milk *after* pasteurization with amounts of copper ranging up to 2.5 parts per million tends to cause a more frequent and more intense development of oxidized flavor than does contamination with identical amounts of copper *before* pasteurization.

Raw milk, when contaminated with the above-stated amounts of copper, tends to develop oxidized flavor of about the same intensity as occurs in the same milk contaminated with identical amounts of copper *after* pasteurization, but of a greater intensity than occurs in the same milk contaminated with identical amounts of copper *before* pasteurization.

The exposure of milk to the air while being passed over a surface cooler does not, *per se*, cause any greater development of oxidized flavor than does the passage of milk through an internal cooler.

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AMYLASE IN COW'S MILK

G. A. RICHARDSON AND C. L. HANKINSON

University of California, Davis, California

Recent workers (1, 2), interpreting Kuhn's (3) findings, apparently have accepted the assumption that α -amylase catalyzes the hydrolysis of central glucosidic linkages in the amylose molecule, thus accelerating starch dextrinization, with little or no accompanying saccharification. It has also been assumed that β -amylase induces saccharification without dextrinization, or at least considerable amounts of reducing material are produced before the blue coloration of the starch by iodine has disappeared. If this assumption is correct, then one may accept the evidence of the presence of α -amylase (dextrinizing-amylase) in cow's milk.

Sato (4) found that 100 ml. of raw cow's milk incubated for 24 hours at 40° C. converted 36 mg. of soluble potato starch into a form which no longer yielded the blue color with iodine. Likewise Chrzaszcz and Goralowna (5-6) by the starch-iodine method (using both raw and soluble starch) found that amylase is present in all samples of raw milk, its concentration being dependent upon the richness in fat, the stage of milking (foremilk being less rich in amylase than the strippings), the feed of the cow, the age of the cow and the health of the udder. These workers found that 100 ml. of normal milk could dextrinize 0.05-0.1 g. of soluble starch in 60 minutes at 30° C. In contrast to these findings, Manicattide, Bratescu and Popa (7) using a modification of the Wohlgemuth Method found that the great majority of samples of cow's milk contain no amylase, that a few samples contain from 2 to 4 Wohlgemuth units per ml. in contrast to human milk samples which contain from 128 to 512 units per ml.

Chrzaszcz and Goralowna (5), apparently the only workers to report a saccharifying enzyme in cow's milk, did not state the source of the milk samples, failed to use an antiseptic agent during incubation and made no mention of precautions taken to assure the milk samples were from normal, healthy udders. Kuttner and Somogyi (8), studying the saccharogenic power of cow's milk by employing pure corn or rice starch, reported amylase entirely absent. Their results are vitiated somewhat by the facts that soluble starch is the accepted substrate in such studies and that too minute amounts of milk were employed especially for so short an incubation period as 30 minutes.

This evidence of the incompleteness of knowledge concerning the presence of a true amylase in cow's milk suggested the desirability of undertaking a further study using the following criteria:

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- (1) The starch-liquefying power of milk as measured by viscosity changes.
- (2) The dextrinizing power of milk according to starch-iodine reactions.
- (3) The saccharogenic power of milk as determined by increase in reducing power.

EXPERIMENTAL

(1) *Starch Substrates.* All starch substrates, except one, were 1.5%, prepared according to the method of Jozsa and Johnston (9). One soluble starch solution was prepared according to Gould (10).

(2) *Source of Milk.* The raw market milk supply of the Univeristy Farm Creamery furnished the majority of the mixed milk samples for the experimental work. When freshly drawn milk from individual cows was desired, samples were drawn aseptically into toluene from cows of known history. The diagnosis of mastitis was made according to methods outlined by Plastringer, Anderson, White and Rettger (11).

(3) *Milk Sera.* The lead sera were prepared by adding 3.0 ml basic lead acetate solution (sp. g. 1.2) to 100 ml. of milk with intermittent shaking, and subsequent filtering. In those samples which were drawn aseptically into toluene and where bacteria were to be eliminated, the lead serum was filtered through L3 Pasteur-Chamberland filters at a reduced pressure of 15 inches, sterile apparatus being used. Precautions against the introduction of saliva were taken by the use of cotton-plugged pipettes.

Iron sera were prepared by the addition of 15 ml of a 1.5 per cent solution of dialyzed colloidal iron to 5 ml. of milk diluted with 15 ml. of water, with vigorous shaking, and subsequent filtering. In those experiments where bacteria were to be eliminated the filtrates were again filtered through the Pasteur-Chamberland filters.

(4) *Procedure for measuring starch liquefying power.* The reaction mixture of milk, or milk serum, and freshly prepared raw potato starch, was placed in an Ostwald pipette, with outflow time of approximately 100 seconds for distilled water at 20° C. The pipette was placed in a water bath maintained at $37 \pm 0.1^\circ$ C. Boiled controls were used in every case. Inasmuch as the two ingredients were tempered in the bath prior to mixing, the outflow time of the mixture could be taken immediately upon being placed in the pipette. Outflow time was again recorded at the end of 1 hour.

(5) *Procedure for determining starch dextrinization.* To a series of test tubes containing increasing amounts of starch were added 10 ml. of milk and 0.3 ml. toluene. After thorough shaking they were incubated at 37° C. for 1, 5, and 24 hours. At the conclusion of the respective incubation periods 1 ml. of 0.083 N iodine-potassium iodide solutions (prepared according to Gould (10)) was added to each tube and the resultant colors recorded. Soluble potato starch and corn starch were compared using raw milk; raw and

pasteurized (61.5° C. for 30 minutes) milks were compared using soluble starch. In some trials lead or iron sera were prepared from the incubated samples, and to each was added 1 drop of 0.033 N iodine-potassium iodide solution, and the colors recorded.

(6) *Procedure for measuring starch saccharification.* Reaction mixtures consisting of 100 ml. of milk, 30 ml. of starch, and 5 ml. toluene were incubated at 37° C. for various intervals. Reducing sugar determinations were made before and after incubation using the method of Cole (12) and the percentage increases in reducing material were calculated.

RESULTS

Liquefaction. Ten samples of milk were employed to compare the decrease in viscosity of potato starch—raw milk (or milk serum) mixtures and potato starch—boiled milk (or boiled milk sera) mixtures. Table I shows that in all cases the decrease in viscosity at the end of one hour's incubation was appreciably greater in the case of the raw milk than in the boiled control.

TABLE I
Liquefaction of potato starch at 37° C. by milk

SAMPLE NUMBER	DECREASE IN VISCOSITY IN ONE HOUR	DECREASE IN VISCOSITY OF BOILED CONTROL IN ONE HOUR	NET DECREASE IN VISCOSITY IN ONE HOUR	RATIO OF ENZYME PREPARATION TO STARCH	HISTORY OF ENZYME PREPARATION
	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>		
1	28.0	11.7	16.3	1:1	Fresh raw market milk
2	29.9	11.7	18.2	1:1	" " " "
3	36.9	9.4	27.5	1:1	" " " "
4	21.7	9.7	12.0	1:10	" " " "
5	24.1	9.9	14.2	1:10	" " " "
6	22.9	5.4	17.5	1:10	" " " "
7	7.5	4.0	3.5	1:10	Serum from raw market milk
8	9.6	4.0	5.6	1:10	Serum from milk of Cow No. 174*
9	7.6	4.0	3.6	1:10	Serum from milk of Cow No. 191*
10	8.0	4.0	4.0	1:10	Serum from milk of Cow No. 462*

* Lead acetate serum filtered through L3 Pasteur-Chamberland filter; sterile equipment used.

TABLE II
Starch dextrinization by milk

SAMPLE	STARCH	INCUBATED AT 37° C.	hours	STARCH-IODINE COLOR															
				CC. 1.5% STARCH ADDED TO 10 CC. MILK															
				0	0.05	0.10	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0		
1. Fresh raw milk	soluble		1					Y*	Y	Y	B*	B	B						
“ “ “	corn		1	Y	Y	B	B	B											
2. Fresh raw milk	soluble		1	.				Y	Y	B	B	B	B	B	B	B	B		
“ “ “	“		5					Y	Y	Y	B	B	B	B	B	B	B		
“ “ “	“		24					Y	Y	Y	Y	Y	Y	Y	Y	Y	B		
3. Fresh pasteurized milk (61.5° C. for 30')	soluble		1	Y	B	B	B	B											
“ “ “	“		5	Y	B	B	B	B											
“ “ “	“		24	Y	Y	Y	B	B											

* Y—Yellow.
B—Blue.

No attempt was made to determine the liquefion value (9) of milk, but it is apparent that considerable variation exists between milks from various sources. The lower values obtained with the lead sera may be partially explained on the basis of lead toxicity and partially on the possibility of amylase adsorption on the precipitated milk solids. The milks for samples 8, 9, and 10 were taken aseptically into toluene, the lead sera obtained, and these filtered through the Pasteur-Chamberland filters. The results indicate that the agent of liquefaction was not elaborated by bacteria during incubation. It is of interest to note that sample No. 8 was positive to the tests for chronic mastitis.

Dextrinization. Table II substantiates the findings of several investigators (Sato (4), Chrzaszcz and Goralowna (5)), that milk is able to dextrinize soluble starch. Soluble starch undergoes conversion more readily than corn starch and pasteurization at 61.5° C. (142.5° F.) for 30 minutes serves to retard the enzyme action, although it is not entirely destroyed. The milk samples studied were obtained from a commercial milk supply.

Saccharification. In view of the relatively high concentration of lactose in milk and the low concentration of amylase no attempt was made to isolate maltose from the incubated samples. It seemed justifiable to assume that an increase in reducing power of the mixtures would be due to maltose formation according to Freeman and Hopkins (13). Table III shows a progressive

TABLE III
Saccharification of starch by milk

INCUBATED AT 37° C.	SOLUBLE C. P.			RAW POTATO			RAW CORN		
	Reducing Material*	Increase		Reducing Material	Increase		Reducing Material	Increase	
hours	ml. per cent	per cent		ml. per cent	per cent		ml. per cent	per cent	
0	5.27	4.43		5.00	4.64	—	5.27	4.43	—
5	5.08	4.59	.16	4.97	4.67	.03	5.10	4.58	.15
24	5.00	4.66	.23	4.93	4.71	.07	5.10	4.58	.15
Iodine color after 24 hours			yellow			blue			blue

* Calculated as lactose hydrate.

increase in reducing substance with increasing duration of incubation in the case of both soluble starch and raw potato starch with a tendency to reach a maximum in the case of corn starch. The color reaction with iodine at the end of the 24 hour incubation period was yellow with the soluble starch, and blue with the raw potato and corn starches. The color with iodine at the end of the incubation period for a given concentration of amylase depends upon the kind of starch used, the concentration of the starch and the length of the

TABLE IV
Amylase in milk sera filtered through the L3 Pasteur-Chamberland filter

SERIES NO.	TREATMENT OF SERUM	SOLUBLE STARCH SUBSTRATE	RATIO OF STARCH TO SERUM	REDUCING MATERIAL				INCREASE IN REDUCING MATERIAL	IODINE COLOR
				Before Incubation	Incubated at 37° C. for 24 hours	Decrease			
						ml.	ml.			ml.
1	Lead, diluted 1-7, unfiltered	Jozsa and Johnston 1.5%	1:10	4.12	3.98	0.14	0.14	Deep blue	
	Lead, diluted 1-7, filtered	“ “	“	4.12	4.00	0.12	0.12	Deep blue	
	Lead, diluted 1-7, unfiltered	Gould, 1%	“	4.12	3.92	0.20	0.20	Red-blue	
	Lead, diluted 1-7, filtered	“ “	“	4.12	3.95	0.17	0.17	Red-blue	
	Lead, concentrated, filtered	Gould, 1%	1:5	4.02	3.85	0.17	0.18	Red	
2	Lead, concentrated, filtered	“ “	2:5	4.05	3.87	0.18	0.19	Blue	
	Lead, concentrated, filtered	“ “	3:5	4.12	3.95	0.17	0.17	Blue	
	Iron, dilute, filtered	Gould, 1%	1:20	5.08	4.92	0.16	0.13	Light blue	
3	“ “	“ “	1:10	5.25	5.07	0.18	0.13	Deep blue	
4	Iron, dilute, filtered	Jozsa and Johnston 1.5%	1:20	4.00	3.87	0.13	0.14	Deep blue	
	Fresh raw market milk	“ “	3:10	3.93	3.80	0.13	0.14	Red-blue	

* Calculated as lactose hydrate.

incubation period. The temperature of incubation, the pH of the reacting mixture, and the presence of activators are other factors which must be considered if quantitative values are to be determined.

That the presence of amylase in milk is not due to bacterial activity is illustrated in Table IV. The milk samples were drawn aseptically into toluene, and the lead or iron sera were procured. Portions of these sera were filtered through Pasteur-Chamberland filters and the various mixtures of sera and starch were incubated at 37° C. for 24 hours. Amylytic activity is shown by increased reducing values of the mixtures at the end of incubation, amounting to from 0.13 to 0.20 per cent sugar. The concentration of the starch was such that dextrinization was never complete at the end of incubation.

Heat stability. The amylase activity of milk has been utilized to detect the improper pasteurization of milk or the presence of raw in pasteurized milk (10, 14, 15). It has been reported (16) that α -amylase is less resistant to heating than β -amylase, although Kuhn (3) did not find it necessary to postulate differences in heat stability. The following study was designed to determine the effect of heating milk at various temperatures on both the dextrinizing and saccharifying amylases of milk as well as to demonstrate further the presence of both α - and β -amylases in milk.

Raw market milk was heated in flasks in water baths at 50°, 55°, 60°, 65° and 70° C. for 30 minutes. One sample was flash heated at 90° C. They were then cooled to room temperature in ice-water, and reducing values determined. Mixtures of these milks with starch (20 ml. milk, 6 ml. of 1.5% soluble starch, 1 ml. toluene) were incubated at 37° C. for 24 hours. Reducing values of the mixtures were made, and the reactions of the lead sera with iodine were observed. A milk-toluene mixture was used as a control.

As shown in Table V, no significant difference in saccharogenic activity was found between raw milk and the milk heated for 30 minutes at 50, 55, 60, or 65° C. Milk heated at 70° C. for 30 minutes, or flash heated to 90° lost practically all of its power to increase the reducing value of the starch—milk substrate. In contrast, the starch dextrinizing activity of milk was adversely affected by the various heat treatments at temperatures of 55° C. and higher. From this it is inferred that starch saccharifying and starch dextrinizing enzymes are present in milk, and that the former is much less heat labile than the latter.

Effect of Incubation Temperature on Saccharifying Power. Rumsey (17) reported that the saccharifying amylase of flour exhibited maximum activity in the pH zone of 4.0–5.3 and with increasing temperatures up to 55° C. Chrzaszcz and Goralowna (5) found that normal milk showed an optimum dextrinizing activity at pH 5.8 to 6.2 at 30° C. The temperature of 30° C. was also found to be optimum for saccharifying action. The data shown in Table VI agree only in part with the latter findings. Raw market milk was

TABLE V
Heat Labilty of Milk Amylase

TREATMENT	SUGAR DETERMINATIONS			IODINE TEST 1 cc 0.01N I-KI per 5 cc serum
	Sugar solution	Decrease	Increased reducing material	
	ml.	ml.	per cent	
Raw (before incubation)	5.17	—	—	Blue
Incubated 24 hrs. at 37° C.:				
Raw	4.83	0.34	0.30	Yellow
50° for 30 minutes	4.82	0.35	0.31	Yellow
55° " " "	4.85	0.32	0.29	Blue
60° " " "	4.83	0.34	0.30	Blue
65° " " "	4.80	0.37	0.33	Blue
70° " " "	5.10	0.07	0.06	Blue
90° (flash)	5.15	0.02	0.02	Blue

* Calculated as Lactose hydrate.

used, and mixtures prepared in the ratio of 10 of milk, 3 of 1.5% soluble starch and 1 of toluene. The lead and iron sera were prepared from this mixture in the manner already described. Series of six tubes from each type of mixture were incubated at the temperatures indicated, the water lost through evaporation being replaced before final determinations were made. Milk and milk sera containing no starch when incubated at 30° C. and 70° C. for 24 hours showed no change in reducing value.

The optimum incubation temperature for saccharification is obviously in the vicinity of 50° C., but for dextrinization the optimum temperature

TABLE VI
Optimum Temperature for Milk Amylase Activity

INCUBATION TEMPERATURE	MILK MIXTURE ITSELF INCUBATED FOR 24 HOURS		LEAD SERUM INCUBATED 24 HOURS		IRON SERUM INCUBATED 24 HOURS	
	Increased reducing material	Iodine color	Increased reducing material	Iodine color	Increased reducing material	Iodine color
	per cent*	—	per cent*	—	per cent*	—
Blank (no starch)	**	—	**	—	**	—
30° C.	0.09	Yellow	0.15	Blue	0.07	Blue
35°	0.10	Yellow	0.17	Blue	0.07	Blue
40°	0.12	Yellow	0.17	Blue	0.10	Blue
50°	0.17	Red-blue	0.19	Blue	0.12	Blue
60°	0.12	Blue	0.17	Blue	0.10	Blue
70°	0.06	Blue	0.15	Blue	0.07	Blue
pH	6.71	—	5.88	—	8.48	—

* Calculated as lactose hydrate.

** Blanks incubated at 30° and 70° for 24 hours showed no change in reducing power.

TABLE VII
Variation of amylase in individual cow's milk

COW NO.	NORMAL				COW NO.	MASTITIC			
	Reducing material		INCREASE	IODINE COLOR		Reducing material		INCREASE	IODINE COLOR
	Before incubation	After incubation				Before incubation	After incubation		
172	per cent*	per cent*	per cent*	Red-blue	154	per cent*	per cent*	per cent*	Red-blue
196	4.18	4.34	0.16	Red-blue		4.05	4.36	0.31	
177	4.36	4.52	0.16	Red-blue	174	4.19	4.55	0.36	Yellow
252	4.61	4.77	0.16	Red-blue	180	3.93	4.17	0.24	Red-blue
253	4.40	4.58	0.18	Yellow	183	4.05	4.28	0.23	Yellow
530	4.81	4.94	0.13	Yellow	588	3.99	4.31	0.32	Yellow
532	4.28	4.46	0.18	Red	537 RF	2.67	2.96	0.29	Yellow
542	4.47	4.67	0.20	Red-blue	537 LF	2.74	3.26	0.52	Yellow
526 RF**	4.48	4.67	0.19	Yellow	537 RF	2.27	2.55	0.28	Yellow
526 LF	4.12	4.27	0.15	Red	537 LH	3.76	4.07	0.31	Yellow
526 RH	4.46	4.62	0.16	Red	526 LH	2.10	2.48	0.38	Yellow
	4.34	4.58	0.24	Red					
	Mean		0.174			Mean		0.324	

* Calculated as lactose hydrate.

** Designation of quarters of udder:

RF = right front.

LF = left front.

RH = right rear.

LH = left rear.

is somewhere below 40° C. No detailed study was made to determine the reason for the lower degree of dextrinization in the case of the two sera, but the following differences in conditions are suggestive. The pH values of the reaction mixtures varied from 3.48 to 6.71 and the sera contained either iron or lead in solution. As shown in Table IV, when the starch is in sufficiently low concentration, color differences with iodine are sufficient to indicate dextrinization in the case of both lead and iron sera. Furthermore, it is quite possible that part of the dextrinizing factor may have been removed with the materials precipitated by the lead or iron. This was pointed out by Chrzaszcz and Goralowna (5). The low pH value (3.48) of the iron-starch mixture may partially account for the decreased saccharifying activity.

Variation of amylase in milk. Colostrum and milk from diseased udders show greater dextrinizing activity than normal milk (Chrzaszcz and Goralowna (5)), but nothing seems to have been reported concerning such milks in relation to the saccharifying enzyme. Evidence is fast accumulating to show that the incidence of chronic mastitis is becoming of increasing concern in market milk areas. The data shown in Table VII were accumulated primarily to yield more information on the variation in the saccharifying factor, but also to verify the variation in the dextrinizing factor in milks from normal and mastitic udders or quarters. For this purpose individual cows were selected from one herd; after discarding the first three streams, the samples were drawn into toluene, and the tests were made with a minimum of delay. Mixtures of 5 ml. milk and 1.5 ml. of 1.5 per cent starch were incubated for 24 hours at 37° C. Analyses for reducing material were made before and after incubation. It is evident that some variation exists within the milks of individual cows, whether normal or mastitic. Great differences are found in the milks from normal and mastitic animals, and some variation may be expected even between the milk from the quarters of the same cow. As a general rule it would seem that milk with a high saccharifying activity has high dextrinizing power.

DISCUSSION

The presence of a true diastase in milk is probably of greater theoretical interest than of practical importance either in the nutritional aspect or in connection with dairy technology. Our experiments have demonstrated that milk possesses raw starch liquefying power, soluble starch dextrinizing activity, and the ability to cause an increase in the reducing value of starch. Precautions have been taken to control the origin of the milk samples and to eliminate the possibility of the diastase being elaborated by bacteria as external contaminants of the milk. This was done by aseptic milking into toluene or by filtering the milk so drawn through sterile Pasteur-Chamberland filters. It was felt that these precautions were necessary before confirmation could be given to the report of Chrzaszcz and Goralowna (5) in

the face of the findings of Kuttner and Somogyi (8) and others. This was especially true in view of the very limited and incomplete criteria given by the former authors.

If α -amylase is concerned with starch dextrinization and β -amylase is necessary to produce starch hydrolysis and yield products of higher reducing power than the original, then milk may be said to contain both α and β -amylase. The former is heat labile, its activity being greatly diminished at 55° C. for 30 minutes; the latter withstands heating at 65° C. for 30 minutes with no decrease in activity. These findings, when considered with the evidence of the great variability in the concentration of both the α and β forms in the milks of individual cows, enable one to understand why the starch-iodine reaction is not a safe criterion for the detection of improper low-temperature pasteurization of milk.

SUMMARY

Milk from normal cows has been shown to possess starch liquefying, starch dextrinizing and starch saccharifying activity. Although it did not seem feasible to make optical rotation studies, because of the high lactose concentration and rather weak diastatic activity of milk, it appears justifiable to assume that milk contains an α -amylase as well as a β -amylase. The former is less heat stable than the latter, being considerably inactivated by heating at 55° C. for 30 minutes. The β -amylase of milk maintains its original activity after a period of 30 minutes at 65° C.

The optimum temperature of incubation for determining the α -amylase potency of milk is in the zone 30–40° C., that for the β type is approximately 50° C.

Milk from cows showing evidences of chronic mastitis is characterized by a high, though variable, diastatic activity.

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- Schaefer, O. G., Room 2304, 420 Lexington Ave., New York City, New York.
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- S. M. Piena Razojuumu Kontrolei, Eksportosta, Riga, Latvija, Europe.
- Walters and Rapa, Teatra iela 11, Riga, Latvija.
- Valtion Maitotalouskollaitos, Jokioinen, Finland.
- Maatalouskoelaitos, Kotielainhoito-Osasto, Tikkurila, Finland.
- Rautatiekirjaka uppa, Koydenpunojankatu 2, Helsinki, Finland.
- Valion Neuvontaosasto, Kalevankatu 61, Helsinki, Finland.
- Yliopiston, Kotielainteellinen, Laitos Hallituskatu 13, Helsinki, Finland.
- Le Lait, 61 Boulevard des Invalides, Paris, France.
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- Kasse der Preuss Versuchsanst, Versuchungsanstalt f, Milchwirtschaft, Kiel 5, Germany.
- Joh Palms Hofbuchhandlg, Theatinerstr 19, Munchen, Germany.
- Hirschwaldsche Buchhandlung, Unter den Linden 68, Berlin, N. W. 7, Germany.
- Muller, Robert, Karkste 39, Ecke Charitestr, Berlin, N. W. 7, Germany.
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- Melkcontrolestation V V Z M, Laan van Meerdervoort 18, The Hague, Holland.
- Eyssen, J. H., Alkmaar, Handelskade 50, N. Holland.
- Rijkslandbouwproefstation, Afdeeling Zuivel-Bacteriologie, Hoorn, Holland.
- Coöperatieve, Condensfabriek Friesland, Postbus 82, Leeuwarden, Holland.
- Friesche Coop Zuivel Export, Verseniging, Afdeeling Techniek, Leeuwarden, Holland.
- Hygienisch Laboratorium, Der Veeartsenijkundige, Faculteit, Utrecht, Holland.
- Hollandia Hollandische, Fabriek Van Melk Production, Vlaardingen, Holland.
- Prof. B. Van Der Burg II, Landbouwhoogeschool, Wageningen, Holland.
- Habers, L., Nassauweg 30, Wageningen, The Netherlands.
- Rijks-Serum Inrichting, Rotterdam, Holland.
- Coop Fabriek Van, Melkproduction, Bedum, Holland.
- Keestra, W., Dir Rykszuivelschool, Bolsward, Holland.
- Scheltema and Holkema's Boekhandel and Uitg Mij, Bokin 74-76, Amsterdam, Holland.
- Messrs. Kirberger and Kasper, Ltd., 153 Bokin, Amsterdam, Holland.

Prof. Ritzema, Bosweg 12, Wageningen, The Netherlands.

Bacteriologisch Laboratorium, Unilever N V Nassaukade 3, Rotterdam, Holland.

Director of Agriculture, Madras, India.

Superintendent of Agriculture, Trichur Cochin, S. India.

Office of the Imperial Dairy Expert, No. 12 St. Mark's Rd., Bangalore, S. India.

Government Agricultural Library, Nawabganj, Cawnpore, India.

Office of the Assistant Controller, Dairy Farms, North Circle, Lahore-Cantt, India.

Principal, Punjab Veterinary College, Lahore, India.

Principal, Punjab Agricultural College, Lyallpur, Punjab, India.

Director, Imperial Institution of Veterinary Research, Muktesar-kumaun, U. P., India.

Librarian, Imperial Agricultural Institution, Box No. 18, New Delhi, India.

Secretary, Imperial Council of Agriculture, Imperial Record Building, New Delhi, India.

Director of Agriculture, Bombay Presidency, Poona, India.

Mehta, N. C., Esq., Secretary, Imperial Council of Agriculture, Research Rock House, Simla, India.

Hon. Sec., N. India Christian Tract and Book Society, 18 Clive Rd., Allahabad, India.

The Agricultural Chemist, Government of Bengal, P. O. Ramna, Dacca, India.

Condensed Milk Co. of Ireland, Limerick, Ireland.

Library, Department of Agriculture, Government Building, Upper Merrion St., Dublin, C. 17, Ireland.

Secretary, Irish Agricultural Organization, The Plunkett House, 84 Merrion Square, Dublin, C. 17, Ireland.

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Il Direttore, Inst. Sperimentale, Di Caseificio, Lodi, Italy.

Stazione Sperimentale delle, Malattie Infettive del Bestiame, Via Beloria 10, Milano, Italy.

Istituto Internazionale di Agricoltura, Villa Umberto 1, Rome, Italy.

Istituto Sperimentale Zootechnico, Via Onofrio Panvinio 11-13, Rome, Italy.

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Mr. R. Inous, c/o Sakagawa Dairy, No. 4 Kojimachi-2-Chome, Kojimachi, Tokyo, Japan.

Agricultural and Chemical Institute, College of Agriculture, Tokyo Imperial University, Komaba, Tokyo, Japan.

The Meiji-Seika-Kaisha, "Sei-Nyubu," No. 8 Kyobashi-2-Chome, Kyobashi, Tokyo, Japan.

Miyazaki-Koto-Noris-Gakko, Miyazaki, Japan.

Morioka Imperial College of Agriculture and Forestry, Morioka, Japan.

- The Kawanishi Awazu Farm, c/o Miyuki Post Office Kunai, Nomi-Gun, Ishikawa-Ken, Japan.
- Agricultural Chemistry, c/o Maruzen Co., Ltd., Sanjo-dori, Kyoto, Japan.
- Chikusan, Nogakuku Hokkaido Teikoku, Daigaku, Sapporo, Japan.
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- Suigen-Koto-Norin-Gakko, Suigen Forest and Agricultural College, Suigen, Chosen, Japan.
- The Awaji Rennyu Kabushiki Kaisha, Hirota-umra Mihara-gun, Hyogo Ken, Japan.
- "KaiKeika" Tokyo-Koto-Norin-Gakko, Fuchin near Tokyo, Japan.
- Chikusan, Agricultural College, Kyushu Imperial University, Fukuoka, Japan.
- Nojo, Agricultural College, Kyushu Imperial University, Fukuoka, Japan.
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- Meiji-Seika-Ryogoku Kojo, 15 1 Chome Midori-cho, Honjo, Tokyo, Japan.
- Chikusan Shikenjo, Imperial Zootechnical, Experimental Station, Chiba Shi, Japan.
- Mr. Michio Kasahara, c/o Osaka-Teikoku-Daigaku-Igakubu-Shonika, Osaka, Japan.
- New Zealand Cooperative Dairy Co., Ltd., Hamilton, N. Z.
- Canterbury Agricultural College, Lincoln, N. Z.
- The Laboratories, Glaxo Manufacturing Co., Ltd., Box 259, Hamilton, N. Z.
- Director, Dairy Research Institution, New Zealand Massey Agricultural College, Palmerston North, N. Z.
- Dairy Chemist, Wallaceville per Private Bag, Wellington, N. Z.
- Director of the Dairy Division, Department of Agriculture, Wellington, N. Z.
- Dominion Laboratory, Scientific and Industrial, Research Department, Wellington, N. Z.
- Fisher, W. A., Frozen Products, Ltd., 25-29 Tennyson St., Wellington, N. Z.
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- Trzaska Evert and Michalski, Krakowskie, Przedmiescie 13, Ksiegarnia W-wie, Warsaw, Poland.
- Karnicki, Feliks, Cieszyn, Piaskawa 29, Warsaw, Poland.

- Direcao Jenal dos Seriveos Pecuarios, Service Centrais, Terreiro do Trigo, Lisbon, Portugal.
- S. C. W. A., Ltd., Milk Department, 84 Morrison St., Glasgow, C. 5, Scotland.
- Bryce, Wm., 54 Lothian St., Edinburgh, Scotland.
- Principal, Stellenbosch-Elzenburg, College of Agriculture, Stellenbosch-C. P., Africa.
- Senior Veterinary Officer, Windhok, Southwest, Africa.
- Carruthers, T. D., South West Creamery, Ltd., Box 408, Winhhoek, S. W., Africa.
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- The International House, P. O. Box 4021, Johannesburg, S. Africa.
- Messrs. Virginian Cheese Co., Fourteen Streams, Cape Province, S. Africa.
- Centro De La Industria Lechera, Pasaje Guemes, Edificio Supervielle, Buenos Aires, Argentina, S. A.
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- Universidad de Buenos Aires, Facultad de Agronomia y, Veterinaria, Casilla de Correo, Buenos Aires, Argentina, S. A.
- Sr. Chr. Lauridsen, c/o Escuela Nacional de Agricultura, Cordoba F. C. C. A., Argentina, S. A.
- Instituto Bacteriologico of Chila, Casilla 48, Santiago, Chila, S. A.
- Faculdade De Medicina, Veterinaria Da Universidade, De s Paulo, 16 Eua Sao, Luiz No. 16, Saulo, Brazil, S. A.
- Inspectoria De Fiscalizacado, Do Leite E Lactienios, Service Sanitario Do Estado, De Sao Paulo, 72 Rua Aurora, Sao Paulo, Brazil, S. A.
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- Inst. Municipal de la Nutricion, Gaona 321, Buenos Aires, Argentina, S. A.
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- Chief Dairy Officer, P. O. Box 387, Salisbury, S. Rhodesia.
- Libreria Verdaguer, A Domenech Sen C, Rambla del Centre 5, Barcelona, Spain.
- Laboratorio Municipal, Bailen 43, Madrid, Spain.
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- A. B. Sandberg's Bokhandel, 8 Sturegatan, Stockholm, Sweden.

- A. B. Lundequistska Bokhandeln, Uppsala, Sweden.
 Kgl Veterinarhögskolans Husdjursufelnong, Experimentalfaltet, Stockholm, Sweden.
 Nestle and Anglo Swiss Condensed Milk Co., Service Scientifique, Vevey, Switzerland.
 Landwirtschaftliches Seminar der Eidgenössischen, Technischen Hochschule, Zurich, Switzerland.
- Ecoles et Stations Agricoles Cantionales de Marcellin sur Morges, Switzerland.
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 Wologodakij S/ch Institut, Sowchos "Molotschnoe," P/O Molotschnoe Sewern, Kraja, U. S. S. R.
 Alma Atinskii Sooweterin Inst. ul Sowetskaja 9, Alma-Ata, U. S. S. R.
 Witebakii Sooweterinarn Inst. Weterinarnaja ul I, Witebak, U. S. S. R.
 Inst. Inshen Molotschn Promischl, Ul Truda D 1, Detskoe Selo, Leningrad Obl, U. S. S. R.
 Poltawak Sootechnitsch Institut, Ul Lassalja 3, Poltawa, U. S. S. R.
 Sootechnitsch Institut Im Molotowa, Nowoe Schosse 9, Moskwa 8, U. S. S. R.

Tow Grannikow D A Nautschno-Issled, Laboratorija po Sirodeliju, Glawmasloprom,
Ul Rasina 28, Moskwa, U. S. S. R.

Institut Osoboj Aspiranturi, Biblioteka Ul Worowskogo, Trubnikowskij per 30/a
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U. S. S. R.

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U. S. S. R.

University College of North Wales, Department of Agriculture, Memorial Buildings,
Bangor, N. W.

Edwards, Jack, 13 Great Drakgate St., Aberystwyth, Wales.

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American Dairy Science Association Announcements

STUDENTS' NATIONAL CONTEST IN JUDGING DAIRY PRODUCTS

The team from Ohio State University won highest honors in the dairy products judging contest held in Atlantic City, New Jersey, on October 12, in connection with the Dairy Industries Exposition. The large silver cup which is awarded the team winning first place in judging all products becomes the permanent property of Ohio State University, teams from that institution having won it three times—1933, 1934, and 1936.

Connecticut State College was a close second, followed by Cornell University, University of Nebraska, University of Minnesota, and University of Tennessee. Team from 18 agricultural colleges competed.

These six colleges were each awarded a scholarship to be assigned to any member of the team (including the alternate) whom the college may select. To be eligible for a scholarship, the team member must be a senior and his undergraduate work must be of such character and content as to qualify him to take graduate work leading to a Master's degree in dairy industry.

The six scholarships are annually provided by The Dairy and Ice Cream Machinery and Supplies Association, Inc., which association has for seven years joined with the American Dairy Science Association in sponsoring this contest. The former association also provides five silver cups which are awarded to the team scoring first place in judging all products and the teams winning first place in the judging of butter, cheese, milk, and ice cream; also gold, silver and bronze medals to the individual contestants who win first, second, and third places, respectively, in judging each product and all products. The winning contestant in judging milk was also awarded a gold medal by The International Association of Milk Dealers, and the winner in judging ice cream a gold medal by the International Association of Ice Cream Manufacturers.

Following are the teams and individuals who won high standings in the contest:

ALL PRODUCTS			
<i>Teams</i>		<i>Individuals</i>	
1—Ohio State University .	308.60	1—Joseph Adams, Ohio State University	93.75
2—Connecticut State College	315.85	2—Albert S. Tomlinson, Cornell University	94.00
3—Cornell University	342.35	3—Oscar H. Johnson, Connecticut State College	98.05
4—University of Nebraska	373.35	4—Gifford G. Danke, University of Wisconsin	99.85
5—University of Minnesota .	374.00	5—John F. Rowilson, Connecticut State College	102.25
6—University of Tennessee .	376.70		

BUTTER

<i>Teams</i>			<i>Individuals</i>	
1—Iowa State College	60.75	1—John T. Griffith, Iowa State College	12.50	
2—University of Minnesota	65.00	2—Henry E. Butler, University of Maryland	12.75	
3—Michigan State College	66.50	3—John C. Pfeffer, University of Illinois	14.50	
4—Connecticut State College	70.50	4—R. D. Kilpatrick, University of Tennessee	15.50	
5—University of Wisconsin	72.25	5—Gifford G. Danke, University of Wisconsin	16.50	

ICE CREAM

<i>Teams</i>			<i>Individuals</i>	
1—Cornell University	82.00	1—Albert S. Tomlinson, Cornell University	19.50	
2—Connecticut State College	86.10	2—Gifford G. Danke, University of Wisconsin	24.10	
3—Purdue University	86.90	3—F. W. Skolton, Ontario Agricultural College	24.60	
4—University of Minnesota	89.80	4—Oscar H. Johnson, Connecticut State College	24.80	
5—Ohio State University	89.90	5—Joseph Adams, Ohio State University	25.00	

MILK

<i>Teams</i>			<i>Individuals</i>	
1—Ohio State University	68.45	1—Russell Fifer, Ohio State University	19.70	
2—Pennsylvania State College	83.80	2—Albert S. Tomlinson, Cornell University	21.00	
3—Connecticut State College	86.75	3—James B. Hamilton, Ohio State University	22.25	
4—Cornell University	89.10	4—Gifford G. Danke, University of Wisconsin	23.25	
5—University of Nebraska	92.50	5—Herman Openlander, Michigan State College	24.25	
		5—John F. Rowison, Connecticut State College	24.25	

CHEESE

<i>Teams</i>			<i>Individuals</i>	
1—University of Tennessee	66.00	1—William M. Roberts, University of Tennessee	17.00	
2—Connecticut State College	72.50	2—Maynard C. Stearns, University of Wisconsin	19.00	
3—Cornell University	75.50	3—Grant Hartman, University of Illinois	21.00	
4—Ohio State University	76.25	4—F. G. Warron, Kansas State College	21.25	
5—University of Nebraska	82.00	5—John B. Wilcox, Cornell University	22.25	

ERRATA

Page 171. The second sentence of the second paragraph should read as follows: "To meet the legal standard and to provide a factor of safety, it became the occasional practice of some milk distributors to standardize solids-not-fat by the addition of condensed skimmilk, the amount used varying with the season of the year."

Page 338. Insert at bottom of formula for lactose desoxycholate agar the following: "neutral red .. 0.33 grams."

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ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

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ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

BUTTER

Arachidonic acid in butter fat. A. W. BOSWORTH AND E. E. SISSON, Dept. of Phys. Chem., Ohio State Univ., Columbus, Ohio. J. Biol. Chem. 107, 489, Nov. 1934

The methyl esters of the fatty acids in butterfat were fractionated and the fraction of B. P. 210°–215° C. at 5 mm. pressure, or C₂₀ fraction investigated. Stearic and behenic acids were found but no arachidic could be isolated. The unsaturated acid,—arachidonic—was separated as an octabromide of both the acid and its methyl ester.

CHEESE

The manufacture of low-acid rennet-type cottage cheese. H. L. WILSON AND C. S. TRIMBLE, Bur. of Dy. Ind., U. S. Dept. of Agr., Washington, D. C. Issued Oct. 1931. Revised Feb. 1934. U. S. Dept. Misc. Pub. No. 119

A summary of the recommended procedure for making a low-acid rennet-type of cottage cheese follows:

1. Pasteurize the skim milk by heating it to 145° F. and holding at that temperature for 30 minutes before cooling.

2. Add 10 per cent of good starter and 1 cc. of rennet per 1000 pounds of milk. Incubate at 86°–92° F. 4 to 6 hours or until whey acidity is 0.5 per cent. (A less satisfactory method is to add 0.5 to 1 per cent of starter, $\frac{1}{4}$ to 1 $\frac{1}{4}$ cc. of rennet per 1000 pounds and incubate at 72°–76° F. for 8–10 hours.)

3. Fill the jacket with water at 115° F. and cut the curd in cubes. Bring the temperature of the cut curd to 100° F. as rapidly as possible by adding 115° F. water directly to the vat.

4. Cook the curd slowly to 118°–130° F. in 1 to 2 hours. (Keep the water in the jacket 25–35 degrees warmer than the curd.)

5. When the curd retains its original shape after squeezing, draw the whey.

6. Wash the curd two or three times with cold water to remove the whey acid.

7. Trench and drain the curd for an hour and then pack in trays or containers with perforated bottoms and store at 40° F. for at least 4 hours.

8. To each 100 pounds of curd add 1 pound of salt and 60–75 pounds of a mixture of milk and cream containing 15 per cent of butterfat. Store at 30°–40° F. for a few hours before packaging.

Manufacture of cream cheese involving the use of dry skim milk. W. H. E. REID AND H. R. ALLEY, Dairy Dept., Mo. Agr. Exp. Sta., Columbia, Mo. Mo. Exp. Sta. Cir. 179, July 1934

The advantages of using dry skim milk when manufacturing cream cheese are:

1. Less fat is necessary so that the cheese is more palatable, less sticky, and has better keeping qualities.
2. The life of the cheese is prolonged by the addition of as much as 18 per cent of dry skim milk.
3. The texture of the cheese is improved, producing a smoother and more even spread, and the wheying off of the cheese is reduced.

The formula found to produce the most desirable cheese is as follows:

Butterfat—20 per cent

Dry skim milk—18 per cent

Gelatin—0.4 per cent (280 Bloom test)

Salt—0.75 per cent

Starter—3 per cent for immediate consumption, or 1 per cent if it is to be held in storage 7 to 10 days prior to delivery to the consumer.

CONDENSED AND DRY MILK

Precise determination of calcium, magnesium, and phosphorus in evaporated milk. C. H. WHITNAH AND H. L. ANDERSON, Kansas State Agric. College, Manhattan, Kansas. Ind. and Eng. Chem. (Anal. Ed.) 7, No. 1, p. 46, Jan. 1935

The authors sought to increase the precision of the determinations of these elements, through refinements of manipulation, *i.e.*, good control of ashing temperature and temperatures of ignition of precipitates and the use of a high precision balance (accurate to 10 micrograms).

Details of the procedure and the results of a number of analyses are given. The author concludes that with the precautions observed it is possible to determine the calcium, magnesium, and phosphorus content of evaporated milk with a variation of less than 2 parts per million.

ICE CREAM

Effect of aging treatment on the bacterial count of ice cream mixes:

W. S. MUELLER AND R. L. FRANCE, Dairy Dept., Mass. Agr. Exp. Sta., Amherst, Mass. Mass. Agr. Exp. Sta. Bull. No. 314, Oct. 1934.

In a previous study it was found that by aging ice cream mixes for 4 hours at 68° F. the efficiency of the gelatin was increased enough to permit the use of only three-fourths the usual amount without affecting the quality of the ice cream.

From a study of 18 mixes it was concluded that aging of pasteurized mixes for 6 hours at 68° F., whether followed by an 18-hour aging period at 88° F. or not, did not result in a significant increase in the number of bacteria present. Pasteurized mixes held at 68° F. did not show a definite bacterial increase until after the tenth hour.

Aging unpasteurized mixes, as well as pasteurized mixes contaminated after pasteurization, at 68° F. for six hours resulted in a material increase in the number of bacteria present.

A study of the cause of a stale metallic flavor in strawberry ice cream.

P. H. TRACY, R. J. RAMSEY, AND H. A. RUEHE, Dairy Dept., Ill. Agr. Exp. Sta., Urbana, Illinois. Ill. Agr. Exp. Sta. Bull. 407, Nov. 1934

The elimination of copper contamination is the most necessary step in preventing the development of a stale metallic flavor in strawberry ice cream. This off-flavor is associated with the oxidation of the butterfat, as shown by oxidation-reduction measurements made on experimental batches of ice cream. The addition of copper to the ice cream mix catalyzes the oxidation reaction. Ice-cream plant operators need not be troubled with this flavor defect if they exercise proper care in the selection of dairy products and take the necessary precautions to avoid copper contamination of the mix or any of its constituents.

The development of a stale metallic flavor in strawberry ice cream can be retarded by homogenizing the mix at a high pressure, by heating the berries, by soaking the fruit in the mix before freezing, or by increasing the amount of the fruit added or increasing the fiber content of the berries.

Since the off-flavor developed more rapidly in ice-cream mixes to which strawberries were added than in the control mix to which no berries were added, and since the use of the fruit fiber was shown to check the development of the defect, strawberries apparently contain two agents affecting fat oxidation, one serving as a catalyst and the other as a reducing agent. The former is contained in the juice and the latter is associated with the fibrous material. Increasing the citric acid content of the berries did not hasten the development of the defect.

The fact that different commercial pack berries varied in their ability to cause the stale metallic flavor can probably be attributed to the difference in concentration of pack or to the proportion of fiber as well as to the heat treatment given the berries before or after canning. Fruits other than strawberries, such as oranges, lemons, and pineapple, were also found to accelerate the reaction responsible for the off-flavor.

Six of the most common varieties of strawberries grown in southern Illinois were tested for their desirability as a source of flavor in ice cream. These varieties ranked in the following order of preference: Dunlap, Parson Beauty, Gandy, Premier, Gibson, Aroma. The average net weight of Dunlap berries was found to be 24.5 pounds per case of 24 boxes. The average yield per case of 2:1 pack was 4.2 gallons; of 3:1 pack, 3.85 gallons; and 4:1 pack, 3.7 gallons. Either 2, 3, or 4 parts of berries to 1 part of sugar made a desirable pack as far as flavor was concerned. When it was desired to keep the fruit whole, a pack of 3 or 4 parts of

berries to 1 part of sugar or 40 per cent sugar sirup solution was found to be preferable.

Some physico-chemical properties of lactose V. The influence of other substances upon the equilibrium rotation of lactose. B. L. HERRINGTON, Dept. of Dairy Industry, Cornell Univ., Ithaca, N. Y. JOUR. OF DAIRY SCI., Vol. 17, No. 11, p. 701, 1934.

In the investigation of the effect of water concentration upon the equilibrium between the mutarotating forms of lactose, it was found that the equilibrium rotation of lactose was increased about 6.5 per cent by the substitution of glycerol for water as solvent. The equilibrium rotation was also changed by the addition of salts to aqueous solutions of lactose. In most cases, the rotation was increased. The magnitude of the change in rotation depended upon the concentration of both sugar and salt. The results can be explained by assuming that compounds of lactose and salts exist in solution.

Methods of testing frozen cream. H. C. TRELOGAN AND W. B. COMBS, Dairy Dept., College of Agr., St. Paul, Minn. JOUR. OF DAIRY SCI. Vol. 17, No. 11, p. 717, 1934.

In this investigation 5-gallon lard cans were filled with sweet cream testing about 40 per cent of fat and placed in cold storage at -24° F. The fresh sweet cream was sampled and tested before freezing. The cream was sampled when frozen by scraping off any foam and fragments of cream were chipped off with a screw driver. Some of the frozen chips were weighed directly into the test bottle and some were melted before weighing.

The weighing of the frozen chips proved a little more accurate than melting the cream before weighing. An average of 6 analyses on one sample agreed within 0.5 per cent of the test of the fresh cream before freezing.

MILK

The lipids of milk. I. The fatty acids of the lecithin-cephalin fraction. FLOYD E. KURTZ, G. S. JAMIESON AND GEORGE E. HOLM, Bureaus of Dairy Ind., and Chem. and Soils, U.S. Dept. of Agr., Washington, D. C. Jour. Biol. Chem. 106, 717, Sept. 1934

A quantity of lipid material was extracted from sweet cream butter-milk powder, freed from glycerides, and separated into a lecithin-cephalin and a sphingomyelin-cerebroside fraction.

Analysis for the fatty acid content of the former showed the following results: myristic, 5.2 per cent, stearic, 16.1 per cent, arachidic, 1.8 per cent, oleic, 70.6 per cent, and dicostetrenic (?) 6.3 per cent.

It is surprising that palmitic acid, which is present in milk fat in relatively large quantities is entirely absent in this phospholipid material.

Certain foam producing substances in milk. S. ANSBACHER, G. E. FLANIGAN, AND G. C. SUPPLEE, The Dry Milk Co., Research Lab., Bainbridge, N. Y. JOUR. OF DAIRY SCI. Vol. 17, No. 11, p. 723, 1934.

Certain commercial caseins possess high foaming properties. Such caseins were shaken in a dilute sodium chloride (common salt) solution and the foam producing substance was removed from the casein and was dissolved in the salt solution. About 3½ ounces of the freshly prepared salt solution could be whipped to yield nearly 4 cubic feet of foam. This salt solution contained only 0.07 per cent of salt-free solids which was 13.64 per cent nitrogen, 0.72 per cent phosphorus, and 0.6 per cent sulfur.

This foam producing substance greatly reduced surface tension. Its solution became turbid at 23° C. (73° F.) or above and the solution became colorless at lower temperatures. When freshly prepared the pH was 4.2 but it shifted in 3 days to 5.8 at which pH it formed a flocculent precipitate. By whipping the salt solution, the foam producing substance could be quantitatively removed in the foam. The foam producing solution was altered by aging.

The addition of 5 cc. portions, of this salt solution containing the foam producing substance, to 200 cc. portions of milk produced material increases (from 25 to 62 per cent) in the volume of the cream layer.

Cream flavors and viscosity as affected by the temperature of pasteurization and of the heating medium. J. C. MARQUARDT AND A. C. DAHLBERG, Dairy Dept., N. Y. State Agr. Exp. Sta., Geneva, N. Y. N. Y. Agr. Exp. Sta. Tech. Bull. No. 224, July 1934

For this investigation two 30-gallon vats were used, one being glass lined and the other lined with 18-8 chrome alloy, while in all other respects the vats were identical.

Cream separated from pasteurized milks was free from cooked flavors. Likewise, cream pasteurized at 143.5° F. was usually free from cooked flavors, whereas cream pasteurized at 150° F. usually had a cooked flavor. This flavor was found to be associated more with the fat than with the serum. Cooked flavors apparent two hours after pasteurization sometimes entirely disappeared after 24 or 48 hours' storage at 40° F.

In these experimental vats heating media as high as 210° F. were used when pasteurizing at 143.5° F. without serious flavor effect, but when pasteurizing at 150° F. the temperature of the heating media was a more important factor. When pasteurizing at 150° F. a 180° F. heating medium gave a cooked flavor in 75 per cent of the trials. This flavor always disappeared after storage for 24 hours at 40° F.

Heat-produced films on the walls of the pasteurizing vat had no relation to the development of cooked flavors but did materially reduce the rapidity of heat transfer.

The viscosity of cream was reduced more by pasteurization at 150° F. than at 143.5° F.

The availability of copper in various compounds as a supplement to iron in hemoglobin formation. M. O. SCHULTZE, C. A. ELVEHJEM AND E. B. HART, Univ. of Wisconsin, Madison, Wis. J. Biol. Chem. 106, 735, Sept. 1934

That copper is a necessary supplement to iron in hemoglobin formation is an accepted fact. About 0.005 mg. of Cu per day is enough to produce a distinct response in rats when fed with sufficient iron. However, on a milk diet even greater amounts are ingested and still anemia may result. The explanation seems to lie in the availability of the copper of various compounds. The authors find that the copper of copper caseinate, glycine amide biuret, alanine amide biuret, hemocyanin from *Limulus polyphemus*, and of whole wheat, is readily utilized by anemic rats. Under the same conditions hematoporphyrin is not utilized, even when fed at high levels.

Inhibitors of milk-curdling enzymes. HENRY TAUBER, N. Y. Homeopathic Med. Coll. and Flower Hospital, N. Y. City. J. Biol. Chem. 107, 161, Oct. 1934

Antiproteases of blood serum and egg white are known. The author reports the discovery of a plant antiprotease which exerts a powerful inhibition on the milk coagulating power of proteases. The name, "chymoinhibitors" is suggested for this type of substance. Crystalline urease is a chymoinhibitor and like serum and acetone inhibits the action of pepsin more than that of rennet. It also inhibits the milk coagulating power of trypsin but not its protein hydrolyzing power.

An anemia caused by deaminized casein. ALBERT G. HOGAN AND WALTER S. RITCHIE, Univ. of Mo., Columbia, Mo. J. Biol. Chem. 107, 179, Oct. 1934

When casein is treated with nitrous acid the free amino groups are removed. Rats receiving deaminized casein as the only source of protein survived for only a few weeks. If, when gelatin and gliadin were fed as an adequate protein source, deaminized casein was added to the mixture, the animals became anemic, failed to grow, and died. When deaminized casein was combined with casein in the feed, anemia did not develop.

Further studies on the concentration and chemical nature of vitamin G. LELA E. BOCHER, Dept. of Chemistry, Columbia Univ., New York City. J. Biol. Chem. 107, 591, Nov. 1934

The method for concentrating vitamin G from low lactose whey powder has been previously described by the author. (J. Biol. Chem. 102, 39, 1933.) A further concentration of this vitamin has been accomplished by the use of Lloyd's reagent (specially prepared fuller's earth) with subsequent extraction with dilute pyridine solution.

The resulting product in a dry state is an orange red powder representing a 200 to 300 fold concentration of the vitamin of the whey powder. It carries between 3000 and 3500 units of vitamin G per gram and conforms without qualification to a highly active vitamin G concentrate.

Additional study has confirmed the author's opinion, previously expressed, that vitamin G is itself the water soluble yellow, green-fluorescent pigment of whey, or that the pigment is an integral part of the vitamin.

Rational pasteurization of milk. C. GORINI, *Le Lait* 14, 924-34, Nov. 1934

The efficiency of pasteurization is usually determined by the number of organisms remaining in the milk rather than the type of organisms. The author believes that pasteurization should destroy all pathogenic organisms and the greater part of the saprophytics; and leave unharmed the more resistant lactics. It should also preserve the high value as a food and be satisfactory for making cheese. These milks should keep for 48 to 72 hours at a temperature of 20 to 25° C.

In the pasteurization of milk at a temperature greater than 70° C. (158° F.) the number of lactics able to survive is greatly reduced. In a study of cultures isolated from commercially pasteurized milk he finds that out of each 100, 98 per cent will survive 63° C. (145.4° F.) for 30 minutes, while at 80° C. (176° F.) only 14 per cent survive. He finds that temperature is not the only factor. It has been demonstrated that the thickness of the film heated is important.

Fat soluble vitamins. XII. The carotene and vitamin A content of colostrum. J. SEMB, C. A. BAUMANN AND H. STEENBOCK, Dept. of Bioch., Univ. of Wisconsin, Madison, Wisconsin. *J. Biol. Chem.* 107: 697, Dec. 1934

The vitamin A content of milk fat varies seasonally with the diet and also with the breed of the cow. The work reported is the result of an attempt to ascertain the extent to which this factor varies with the stage of lactation. Butter fats were prepared from the milks of Brown Swiss, Ayrshire, Guernsey, Jersey and Holstein cows and the vitamin A and carotene contents determined on these milks, on the 1st, 2nd, 3rd, 7th, and 30th day following parturition.

The carotene and vitamin A content of milk fat prepared from colostrum was found to be from 5 to 15 times that of the fat of ordinary milks from cows of five different breeds on diets relatively low in carotene.

The vitamin A and carotene content decreased rapidly during the first week of milk secretion. Thereafter the decrease was slow. The carotene content of milk fat varies with the carotene content of the feed. However, this is not true during the colostral period and some potent physiological mechanism must enable the body stores of both carotene and vitamin A to be mobilized to an unusual degree. The vitamin A stores of a new-born calf is low and the high vitamin A and carotene contents of colostral enables the young to build up the stores of these dietary factors.

Chemical control of low temperature pasteurization. JEAN PIEN AND JACQUES BAISSÉ. *Le Lait* 14: 934, Nov. 1934.

In the method of Schern-Gorli, a colored cream layer is produced in raw milk heated at temperatures below 58° C. (136.4° F.) for 30 minutes, with the addition of a small quantity of a suspension of red blood corpuscles and a colorless layer is produced if heated at higher temperatures for the same length of time. The authors have developed a reagent which has a thermal limit of 67°–68° (152.6°–154.4° F.) instead of 58° C. This reagent is prepared by dissolving 1 gram of casein in sufficient N/10 NaOH to make the solution alkaline, diluting to 100 cc. with H₂O, and adding 1 gram of indigo. Finally add 5 cc. of a 5 per cent phenol solution.

Two drops of this solution are added to 5 cc. of milk and the mixture held for 2 hours, when the cream layer will have formed. Holding at 30° C. decreases the time of its formation. If the milk used has been heated at temperatures of 60°–65° C. (140°–149° F.) for 30 minutes the cream layer will be colored. If heated at 67° C. for 20–30 minutes the cream layer will be colorless. The addition of as small an amount as 5 per cent by volume of raw milk to pasteurized milk produces a double layer in the risen cream. Skimmed milk may be studied by adding thereto a neutral fat to produce a cream layer. Acidity seems to have little effect on the test.

Abstractor's Note: Schern and Gorli (*Le Lait* 12: 17, 1932) used a suspension of red blood corpuscles for a similar test. Kahn and Klemm (*Le Lait* 12: 19, 1932) used charcoal and carmine. See *Abstracts of Milk Literature* (1933) p. 83. The present authors claim greater sensitivity for the test here described.

Cultured buttermilk of the churned variety. A. D. BURKE, Dairy Dept., Alabama Polytechnic Institute. *Milk Dealer*, Vol. 24, No. 3, p. 72, December 1934

Three methods of producing cultured buttermilk are described; the churning method, the granule or churned cream method, and the drop or pellet method.

In the first method, milk containing 1.5 to 2.0 per cent fat is pasteurized at 180° F. for 30 minutes, cooled to 68–72° F., and cultured in the usual

manner. When properly ripened, the curd is broken and the buttermilk is churned or agitated until the fat particles appear about half the size of wheat kernels. Two separate batches of cultured milk are sometimes prepared, one containing 4 per cent of fat, and the other consisting of skim milk. In churning only the whole milk, and mixing with the skim milk afterward, the tendency toward foaming is minimized.

The granule or churned cream method consists of churning cream with a fat content of about 30 per cent until granules of the proper size appear, drawing off the buttermilk, washing the butter particles with cold water, chilling them, and adding them to cultured buttermilk.

The drop or pellet method is given in three steps:

(1) Sweet cream or butter of the finest grade is oiled off by heating in a container placed in hot water. Sufficient time is allowed for the pure butter oil to float to the surface.

(2) A tinned copper trough with holes punched in the bottom, a single row the full length, is prepared. The holes should be small, about the diameter of a large pin shank, to permit the butter oil to drip through in small drops.

(3) The trough is suspended over a vat of cultured buttermilk, properly prepared, and cooled to 45 to 50° F. The butter oil drops, drop by drop, into the cold buttermilk, with sufficient of the buttermilk being maintained. The drops of melted oil flatten and solidify immediately when they strike the cold milk. They remain well suspended and evenly distributed, and produce a very pleasant buttery sensation of rich palatability.

Butter color may be used in all three of the methods.

High potency vitamin D milk. C. I. Post, Mgr. Vitex Dept., National Oil Prod. Co., Inc., Harrison, New Jersey. *Milk Dealer*, Vol. 24, No. 3, p. 39, Dec. 1934

A brief article pointing out the special service which dairies putting out vitamin D milk with added vitamin D concentrate, may render to physicians, by being able to supply, in accordance with his directions, milk having any desired vitamin D content up to 1500 U. S. P. units per quart.

This service, being highly special, is not restricted as to price, and permits the dairyman to profit by the increasing interest in vitamin D therapy on the part of the medical profession.

The manufacture of whipped cream using dry skim milk. W. H. E. REID AND W. C. ECKLES, Dairy Dept., Missouri Agr. Exp. Sta., Columbia, Missouri. *Missouri Exp. Sta. Cir.* 180, July 1934

The advantages of adding dry skim milk to cream that is to be whipped are:

1. Reduces drainage.
2. Improves body of the whipped cream.
3. Improves the flavor and nutritive value of whipped cream
4. Some creams that are undesirable for whipping purposes, are made whippable by the addition of skim milk powder.

From 4 to 6 per cent of the skim milk powder should be added in the form of a paste prepared by mixing with a portion of the original cream. This paste should be added to the cream after it has been cooled and pasteurized. The treated cream should be aged at 40° F. for 12 to 24 hours before whipping. If sugar is added it is best done at the time of adding the skimmilk powder.

Costs and returns in operating milk and cream collection routes in Maine. GEORGE F. Dow, Maine Agr. Exp. Sta., Orono, Maine.
Maine Exp. Sta. Bull. 374, Sept 1934

This study represents an analysis of the costs and returns for collecting milk and cream on 90 collection routes during the year ending June or July 1932. A summary of costs and returns in operating these routes is given in the table.

TABLE 1
*Summary of costs and returns in operating 90 milk and cream collection
Routes during 1931-1932*

	NUMBER OF ROUTES	AMOUNT PFR ROUTE	AVERAGE PRICE	VALUE PFR ROUTE	PER CENT OF TOTAL VALUE
Costs for route:					
Man labor	90	1,998(hrs)	\$ 22	\$439.59	35.9
Use of motor truck	90	15,246(mi)	.05	742.59	60.6
Horse labor	41	248(hrs)	.11	27.27	2.2
Hired hauling	15			15.46	1.3
Total cost	90			\$1,224.91	100.0
Miscellaneous income	28			\$ 44.22	3.6
Net cost for hauling milk and cream	90	5,173(cwt)	\$.23	\$1,180.69	96.4
Total returns for hauling milk and cream	90	5,173(cwt)	\$.34	\$1,771.96	
Net returns	90	5,173(cwt)	\$.11	\$ 591.27	
Returns for man labor*	90	1,998(hrs)	\$.52	\$1,030.86	

* "Returns for man labor" represents total returns after deducting all collection costs except man labor, and thus represents the amount received by the motor truck operator in payment for his labor in collecting milk and cream.

Volume of milk and cream hauled per mile and miles per trip accounted for 83 per cent of the total variation in cost per hundred-weight for collection. Elimination of competition in hauling might therefore appreciably reduce the hauling cost.

Unimproved roads proved to be an important factor in increasing costs. On collection routes where less than one-fourth of the mileage was found to be improved roads, a saving of 4.7 cents per hundredweight could be made if the roads were all improved. This does not allow for the saving in time to the farmer who has to transport his milk to the hard road when traveling is difficult.

An economic study of the collection of milk and cream in Maine. GEORGE F. Dow, Maine Agr. Exp. Sta., Orono, Maine. *Maine Exp. Sta. Bull.* 373, August, 1934.

Important changes in the collection of milk and cream in Maine from 1928 to 1932 have been studied. In 1928 much of the milk was delivered three times a week but by 1931 practically all the milk was being delivered daily. Cream deliveries increased only slightly—from 2.6 to 3.0 times per week on the average.

From 1928 to 1933 the average hauling distance was approximately tripled as a result of the closing of many local plants. This in turn has resulted in an increase in the quantity of milk and cream gathered on collection routes and a decrease in the amount delivered by individual dairymen.

From 1930 to 1931, 22.4 per cent of the milk was delivered by dairymen, 76.2 per cent by hired collectors, and 1.4 per cent by railroad. In the case of cream the proportions were about the same except that the railroads received a slightly higher percentage of the business. Hired collectors hauled milk about 20 per cent more economically than did individual dairymen for distances of less than 3 miles and 55 per cent more economically for distances of 6.0 to 8.9 miles. Exchange hauling resulted in reduced delivery costs of over 50 per cent when the exchange was made by three or more dairymen.

On three-fourths of the collection routes the hauling charge on milk was the same for long hauls as it was for short hauls. For individual farmers, however, the average hauling cost increased from 27 cents for distances of less than 3 miles to 67 cents for distances of 6 to 8.9 miles, while the average cost of hauling cream increased from 79 cents to \$1.57 per hundred pounds.

Horses were used for delivery by 15 per cent of the dairymen. The cost per mile was three cents greater with horses than with motor vehicles.

The concentration of the dairymen was an important cost factor. The hauling cost for the concentrated producers averaged 29 cents per hundred pounds for milk and 68 cents per hundred pounds of cream, as compared with 41 and 95 cents respectively for the dairymen in less concentrated areas.

Increased volume resulted in decreased hauling cost in the case of delivery by the individual dairymen, but in the case of the collection route the producers volume did not influence the hauling cost.

Undulant fever (Brucellosis) with reference to 148 cases encountered in and about Dayton, Ohio. W. M. SIMPSON. Jour. Ind. St. Med. Assn. 27: 564, Dec., 1934.

In a comprehensive discussion of undulant fever in man, as reported by other investigators and as observed by the author in 148 cases, the writer concludes that "there appears to be but one logical method for preventing the transmission of milk-borne infection to human beings and that is by pasteurization."

An x-ray study of nutritional deviations. T. WINGATE TODD. Jour. Home Econ. 26: 605, Dec., 1934.

Roentgenographic studies have shown that all children require a quart of milk a day to insure the calcium intake necessary for optimum growth and well-being, and that pregnant and nursing women need a quart or more to take care of the demands of the fetus and prevent depletion of their own calcium supply.

The author points out that milk, yielding 325 calories to the pint, is not in itself a fattening food; and that a diet containing adequate amounts of protective foods is more important to good health than is one rich merely in energy-producing foods.

Some ingestion of milk stimulates the flow of gastric secretion, and the amount of fluid in the stomach is doubled in a few minutes, consumption of milk satisfies the appetite. Milk should, therefore, be given to children between meals as well as with meals. When taken with meals, the solid foods induce relatively less gastric secretion. Cloying of the appetite is more pronounced with buttermilk than with whole milk, as shown by the roentgenoscope.

Undulant fever control in Washington Co., Maryland. W. R. CAMERON AND M. WELLS. South Med. Jour. 27: 907, Nov., 1934.

Use of the Huddleson rapid macroscope agglutination test for the diagnosis of Bang's disease in herds supplying milk to Hagerstown, Maryland, is discussed in this paper. Cases of undulant fever were traced to those herds in which more than 20 per cent of the animals were infected. Successful efforts to eliminate the disease from the herds were accompanied by a significant decrease in the number of cases of undulant fever. The Huddleson method is believed to be a "simple and practicable method whereby a health officer may rather quickly determine the possible source of a particular case of undulant fever." The authors further believe that examination of milk serum for diagnosis of Bang's disease and the elimination of diseased animals from herds is an effective method for control of undulant fever wherever pasteurization is impracticable.

Factors influencing the utilization of calcium and phosphorus of cow's milk. J. H. HESS, H. G. PONCHER AND H. WOODWARD. *Am. J. Dis. Child.* 48-1058, Nov., 1934.

Metabolism studies on an infant receiving 100 cc. per kilogram daily of whole cow's milk treated by the base exchange process to lower the curd tension, show that better utilization of the calcium and phosphorus of the milk results than when ordinary milk is used, although there is a reduction in the amount of these two minerals as a result of the base exchange process.

It is believed that the size of the curd, the state of the calcium and the reaction of the ash must be influenced favorably in order to secure more efficient utilization of the minerals.

MISCELLANEOUS

Alcohol-gasoline engine fuels. HARRY MILLER, Idaho Agr. Exp. Sta., Moscow, Idaho. *Idaho Agr. Exp. Sta. Bull.* No. 204, June, 1934.

The blending of alcohol with gasoline was brought to the attention of the American public by the low prices for agricultural products. Ethyl or grain alcohol may be produced from sugar or substances that can be converted into sugar and from ethylene gas. Alcohol may be used as a fuel in internal combustion engines either in the pure state or in conjunction with petroleum fuels, such as gasoline. Anhydrous or absolute ethyl alcohol will mix with gasoline in all proportions. Commercial alcohol (95 per cent purity) will not mix with gasoline unless it constitutes at least 50 per cent of the mixture. However, by adding blending agents, such as the higher alcohols, commercial alcohol can be made to blend with gasoline in any proportion. This can also be accomplished by using a double bowl carburetor connected to separate fuel tanks.

Tin is corroded more by alcohol than by gasoline; iron, lead and aluminum being affected less. Zinc and steel are affected by neither.

There is no danger of alcohol separating from gasoline due to the addition of such amounts of water as are likely to get into the fuel tank by condensation, or by filling the tank during a rain, or by absorption of moisture from the atmosphere.

There is no danger of corrosion from the products of incomplete combustion of a mixture of alcohol and gasoline. No difficulty has been experienced in starting motors when using alcoholic blends. The addition of one-half per cent of oleic acid to the lubricating oil increases the efficiency of such fuels.

The amount of carbon monoxide formed when alcohol is used is reduced about 75 per cent of what is formed from gasoline. The lessened amount of carbon monoxide found is desirable from a hazzard standpoint and results in the liberation of more heat, as one pound of carbon oxidized to

carbon monoxide releases 4,360 B.T.U. compared with 14,600 B.T.U. when oxidized to carbon dioxide. This offsets any difference there may be in the caloric value of gasoline and alcohol.

If 20 per cent of our motor fuel were alcohol derived from agricultural products it would create a market for 2,200,000,000 bushels of corn (1928 crop was 2,500,000,000 bushels) or 113,000,000 tons of potatoes (1928 crop was 14,000,000 tons).

Dry ice would become an important by-product in the manufacture of alcohol from agricultural products. This refrigerant could be made for 0.5 to 0.75 cents per pound. The protein and carbohydrate residue also could be utilized for feeding dairy cattle.

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ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

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ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

CHEESE

Researches on natural rennet and on the cultures employed in cheese-making. W. DORNER, Federal Dairy Research Station, Liebefeld, Bern, Switzerland. *LeLait* 14: 1047-50, Dec. 1934.

Many organisms are introduced into cheese by the rennet used. In a study of several types of rennet employed in Switzerland the author finds the following organisms as common contaminants: *Thermobacterium helveticum*, *Thermobacterium bulgaricum*, *Streptococcus lactis* and *Streptococcus thermophilus*. He proposes the use of these in pure cultures in cheese making.

The changes in acidity due to organisms from rennet depend upon the agents used in preparing rennet, the age and acidity of the preparation. Rennet containing a preponderance of *Streptococcus thermophilus* causes more rapid development of acidity than does that containing the other organisms.

The use of *Bacillus acidophilus* in the manufacture of cheddar cheese.

RENDWICH H. LEITCH. *LeLait* 14: 786-97, Sept.-Oct. 1934.

The author employs a specially prepared culture of acidophilus in the milk for cheddar cheese. He has found that by this method of preparation a cheese may be obtained which has 1,000,000 living organisms per gram after 6 months' ripening and 900,000 after 9 months' ripening.

CONDENSED AND DRY MILK

A summary of various types of infants fed on dry milk extending over a period of fourteen years. M. M. McCORD, *Arch. Pediat.*, Dec. 1933.

Fourteen years' experience with a 12 per cent dry milk in infant feeding, has convinced the author of the value of this product in supplying a clean, uniform, economical, and highly digestible substitute for breast milk. In the feeding of prematures, the convalescent treatment of colitis patients, and as a preventative of rickets, this irradiated dry milk has a valuable function, as well as in the routine feeding of healthy infants deprived of breast milk, and as a safe fluid milk supply.

ICE CREAM

Controlling physical properties of high solids mixes. M. J. MACK, Mass. State College, Amherst, Mass. *JOURNAL OF DAIRY SCIENCE*, Vol. 17, No. 12, p. 781, Dec. 1934.

In some parts of New England the manufacture of ice cream with 18 to 20 per cent of butterfat is gaining in favor. Three serious manufacturing problems are involved, (1) excessive viscosity which adversely affects homogenization, cooling, overrun, and packaging, (2) unsatisfactory melting, and (3) crumbly body. The present investigation was planned to aid in solving these difficulties.

It was found that the troubles were the least noticeable when the source of milk fat was sweet fresh cream. The use of a hand operated reducing valve in the outlet from an homogenizer equipped with a two-stage valve was very helpful. The pressures suggested were 2000, 500, and 150 pounds for an 18 per cent mix and for a 20 per cent mix, 1500, 500, and 150 pounds. Three stage homogenization reduced fat clumping and viscosity. By raising the sugar content to 16 or 17 per cent or by substituting corn sugar for 3 to 4 per cent of cane sugar a less crumbly ice cream which melted more evenly was secured.

Some physico-chemical properties of lactose VI. The solubility of lactose in salt solutions; the isolation of a compound of lactose and calcium chloride. B. L. HERRINGTON, Dept. of Dairy Industry, Cornell University, Ithaca, N. Y. JOURNAL OF DAIRY SCIENCE, Vol. 17, No. 12, p. 805, Dec. 1934.

It was found in this investigation that the addition of calcium chloride to a lactose solution increased the solubility of the latter. That the presence of salts increases the solubility of some sugars has been known for years.

In these experiments, carried out at 32° C. (89.6° F.), a calcium chloride solution of 10.49 per cent increased the lactose solubility from 28.6 to 29.5 grams per 100 grams of water. Some of the lactose was secured by precipitation and analysis showed the crystals to be a compound of lactose with calcium chloride. (Alpha lactose. $\text{CaCl}_2 \cdot 7\text{H}_2\text{O}$). The solubility of this compound in water was determined at 25° C. (77° F.) Supersaturated solutions of lactose in concentrated calcium chloride often resisted all attempts to induce crystallization probably due to the formation of lactose compounds.

Effect of age on the quality of package ice cream. A. C. SCHRICKER, St. Louis Dairy Co., St. Louis. Ice Cream Field, Vol. 26, No. 3, p. 18. Jan. 1934.

The Missouri Association research committee's survey on the age of package ice cream and quality is reported. Ice cream was purchased from dealers at 10 day intervals and scored. Two types of flavors were purchased, a slow and a fast moving flavor. The slow moving ice cream was a special featured package and actually proved to be relatively fast moving.

The results of the Neapolitan brick (chocolate, vanilla, and strawberry) were as follows:

The percentages of the ice cream scoring good on flavor were: Vanilla 77.1 per cent, chocolate 77.1 per cent, strawberry 71.4 per cent. The percentages which scored fair in flavor were vanilla 14.3 per cent, chocolate 11.45 per cent, and strawberry 17.4 per cent. The percentages which scored poor were: vanilla 8.6 per cent, chocolate 11.45 per cent, and strawberry 11.4 per cent. The writer states that in a combination package, the quality is no better than its weakest flavor. The time, then, that a combination like the above would remain salable depends on the keeping quality of the strawberry ice cream.

The texture of the Neapolitan packages were: good, vanilla 65.7 per cent, chocolate 71.4 per cent, strawberry 60 per cent. Slightly coarse were: Vanilla 20 per cent, chocolate 14.3 per cent, strawberry 25.7 per cent. Coarse was 14.3 per cent in all three cases.

In case of the special package, the number of combinations and flavors were so numerous that it was considered desirable to group the results as one with the terms indicating the condition of the flavor as if it were one flavor. The results were 81.5 per cent good, 14.8 per cent fair and 3.7 per cent poor. The special packages scored better than the Neapolitan package as they were fresher and had a better turnover in the cabinet. The percentages scoring good in texture were 78.0 per cent, slightly coarse 14.8 per cent, coarse 7.2 per cent.

The dating code showed that 5.7 per cent of the Neapolitan packages were one week old, 31.4 per cent two weeks old, 17.1 per cent three weeks old, 11.5 per cent four weeks old, 11.5 per cent five weeks old and 22.8 per cent whose age could not be determined. Twenty-two per cent of the special packages were one week old, 48.2 per cent two weeks old, 14.2 per cent three weeks old, 11.2 per cent four weeks old and 4 per cent unknown.

The committee substantiates the importance of age in governing the quality of package ice cream, and suggest a dating system to enable the identification of the age of the packages.

Vitamin D in ice cream. ROBERT T. SMITH, Smith and Clark Co., Scranton, Pa. Ice cream Review, Vol. 18, No. 5, p. 26, Dec. 1934.

The Smith and Clark Company is one of the earliest companies to use vitamin D in ice cream and the copyrighted name "Frozen Sunshine" has been used in the advertising of the product. That this name took the public's fancy is revealed in the sales results that followed and continued to be maintained since its introduction.

Vitamin D being the one vitamin that ice cream lacks, it was decided that its introduction would improve the food value of ice cream and that it would have great sales influence on ice cream especially with the present dealers of the company.

The sales campaign put on within the organization gave the largest increase in sales of any campaign. Gains were obtained in the face of competition with low-priced ice cream. The sales of low-priced ice cream containing no vitamin D declined in favor of a satisfactory increase in the sales of the one containing vitamin D. This showed that high quality can be built up to far exceed in sales a lower priced product which has price as its stimulant.

The following achievements were accomplished by using vitamin D in ice cream:

1. Salesmen became enthusiastic because of opportunities to increase sales.
2. It provided something new upon which to base dealer and consumer advertising.
3. The percentage of dealer turnover was reduced and they were pleased with the demand for the ice cream they were handling.

A new modified Babcock fat test in ice cream. VASILY KNIASEFF, California State Dept. of Agriculture. *Ice Cream Trade Jour.* Vol. 30, No. 12, p. 29, Dec. 1934.

A new method for testing ice cream for butterfat is presented. The test compares quite favorably with the analysis obtained with the Mojonniester. The test is as follows:

1. Weigh 9 grams of ice cream into a 9-gram 50 per cent cream test bottle.
2. Measure 8 mls. of reagent No. 1 into the test bottle; shake the mixture in the test bottle thoroughly.
3. Add 5 mls. of reagent No. 2 into the test bottle; shake thoroughly, but with caution.
4. Place the bottle in a water bath at 183° F. and digest for 15 minutes; shake the bottle carefully three times with moderate motion during digestion.
5. Centrifuge one minute; the temperature of centrifuge during operation should be held within the range of 130 and 165° F.
6. Fill the bottle with hot water up to the bottom of the neck.
7. Centrifuge again one-half minute.
10. Place the test bottle in a water bath (130 to 140° F.) for 10 minutes.
11. Read the fat, using glymol.

The method requires two reagents. Reagent No. 1 is made as follows:

- 1,000 mls. of water.
- 132 grams of sodium hydroxide.
- 34.6 grams of sodium tartarate.
- 42.8 grams of ammonium sulfate.

Reagent No. 2 is made as follows:

250 mls. of ethyl alcohol.

15 mls. of butyl alcohol (normal).

15 mls. of ammonium hydroxide sp. gr. 0.9.

60 mls. of ethyl ether.

60 mls. of petroleum ether.

The reagents are mixed in the order given and the last reagent should be kept in a glass stoppered bottle.

Economies in the use of dry ice. LEWIS C. CHAMBERLIN, Mich. Alkali Company, New York. *Ice Cream Field*, Vol. 26, No. 3, p. 12, Jan. 1935.

The writer points out the various places where economies can be effected in preserving dry ice in the plant. Much of the waste is due to faulty or improper distribution of the dry ice from the source of manufacture to the consumer. This takes place largely in the plant storage containers, which may be damaged, or which may lack proper insulation or are not kept closed, and which may be exposed to the weather.

Attention to home deliveries may save a great deal of dry ice. Much of the ice cream sent out contains too much ice. New types of shipping containers also will reduce the amount of refrigerant needed. Trucks and cabinets have been developed to a point where the cost of this newer refrigerant is quite low. Considerable experimentation has produced a cabinet that is quite economical in the use of dry ice, because of automatic temperature control and other features. One large concern operating 750 cabinets during the past summer did so with a dry ice consumption of 6-14½ pounds per day on 1-4 hole cabinets.

Let bill-boards do the job. T. EDWARD TUFFT, *Ice Cream Trade Jour.*, Vol. 30, No. 12, p. 14, Dec. 1934.

The writer quotes A. A. Comey, President of the Chapman Ice Cream Company of Los Angeles, California, who stated that bill-boards correctly used bring the best results for the least money in selling ice cream. The company uses 58 bill-boards, half of which are illuminated. The cost of advertising has been reduced ½ by using bill-boards. Mr. Comey cites a dozen rules to follow in bill-board advertising. These follow:

"1. The copy should be as brief as possible, only a few words, usually just the name of the product and the name of the company.

2. The designs should be in rich natural colors. The art work must not be imagined, or faked, but it must be done by a good artist from a real photograph of the product.

3. The item and the name of the company must be linked together and so impressed on the public mind.

4. The product presented must have a seasonal appeal. An example of response to seasonal appeal was seen last winter when "frozen Egg Nog"

was shown on the bill-boards and constituted 25 per cent of the company's total gross sales during the three months, although retailing at \$1 a quart.

5. All bill-board copy should be changed every two months. A 30-day change was tried out and it was found too expensive. It brought back the money spent but no profits. A 90-day change was tried out and the last 30 days did not pay a return. The 60-day change always pays a profit.

6. Novelties must not monopolize the boards but must share space and time with the regular products. A half-and-half schedule on the two is perhaps the most effective.

7. Half of the signs should be intended to get the eyes of the night drivers, which is why one-half of the Chapman boards are illuminated.

8. To determine locations of illuminated and non-illuminated signs. Mr. Comey takes his own traffic census. It covers seven days and seven nights. A bill-board should be placed, Mr. Comey states, with as much care as a store is placed, and no board is used where the census shows fewer than 15,000 automobiles a day. In addition, the census must show a sufficient number of people likely to buy a high quality of ice cream.

9. Boards are used only in the better section of the city because much dependence is also placed on the local residents as well as upon general traffic.

10. The signature must stand out, and at intervals the character of the type in the signature must be changed. The idea that a type used in a signature must be used forever to identify a business house does not appeal to Mr. Comey. This year the Chapman signature was changed from a semi-script to a Gothic. It is the name not the kind of type, that counts, he says. A change is effective in capturing the attention.

11. Approximately three numbers a year should be brought out and played up on the bill-boards. Four would not be too many. Bill-boards are always effective in presenting new and novel numbers. They should always tie in with window cards.

12. Only large boards should be used, and as near to important intersections as possible."

MILK

Detection of lactic acid in milk and cream. H. C. TROY AND PAUL F. SHARP, Dept. of Dairy Industry, Cornell Univ., Ithaca, N. Y. JOURNAL OF DAIRY SCIENCE, Vol. 17, No. 12, p. 759, Dec. 1934.

Fresh milk as produced by the cow seldom contains over 0.002 per cent lactic acid. The following delicate accurate test for lactic acid would clearly indicate the extent of souring as it is sensitive to 0.002 per cent lactic acid:

Place 125 cc. of milk (more if cream is used) in an Erlenmeyer flask. Add 1.3 grams of ammonium sulfate for each 2 cc. of water in the product. (The water content need be known only approximately.) Heat the mixture

to 70° C., occasionally shaking vigorously to bring all of the ammonium sulfate into solution. Cool to below 20° C. and filter through a folded filter, refiltering the first portion that passes through the filter. Place 75 cc. of the filtrate in a separatory funnel, add 4 cc. of 5 normal sulfuric acid and 75 cc. of ethyl ether, stopper the funnel, and shake vigorously for 2 minutes. (Much of the ether used in the dairy industry for the gravimetric fat determination is not sufficiently pure, but it may be rendered satisfactory by shaking with water and distilling from an excess of water.) Allow the funnel to stand upright until the ether separates into a clear layer, and then draw off the water portion. Again shake, allow to stand, and draw off the additional water which settles. A third shaking and settling is a good practice.

Remove the stopper, and with a clean, dry cloth wipe the mouth and inside of the neck of the funnel clean and dry. Pour the ether into a glass-stoppered flask, using great care not to allow a single drop of the water phase to flow out with the ether. Add about 0.05 gram of sodium bicarbonate to the ether in the flask, and shake vigorously. Pour the ether into an evaporating dish, and rinse the flask into the dish with 1 or 2 cc. of water. Evaporate the watery liquid to dryness over a boiling water bath. Rinse the dish twice and residue with petroleum ether, using 10 cc. for each rinsing. Warm the dish on hot water each time before discarding the ether.

Place 1 cc. of water in the evaporating dish, and cause it to flow around in the dish to dissolve the residue. Pour the solution into a test tube and rinse the dish twice into the tube, using about 0.5 cc. of water for each rinsing. Carefully evaporate the water from the test tube by holding it in a flame while shaking to avoid spattering. Stop the evaporation when about 0.25 cc. remains. Cool and add 2.5 cc. of concentrated sulfuric acid (sp. gr. 1.84). Place the tube in boiling water for 1.75 minutes, cool, and add one drop of guaiacol reagent (10 per cent of guaiacol in aldehyde-free ethyl alcohol).

A bright purplish-red color developing in a few minutes, which grows to a more intense and darker red on long standing, shows the presence of lactic acid in the milk.

This color test for lactic acid was described by Deniges. "To gain experience and confidence, a sample of milk known to be fresh should be divided into three parts. To the first part add enough lactic acid to make 0.01 per cent, to the second enough to make 0.002 per cent, and add none to the third. Carry out the test for lactic acid on the three parts."

Application of the glass electrode to dairy products. L. R. PARKS AND C. R. BARNES, Penn. State College, State College, Pa. *Ind. and Eng. Chem. (Anal. Ed.)* 7, No. 7, p. 71, Jan. 1935.

The H-ion concentration of pasteurized milk, buttermilk, and cream, and commercial ice cream mix and butter serum, was determined with the

hydrogen, quinhydrone, antimony, and glass electrodes. The authors conclude from their results that the hydrogen-ion concentration of dairy products may be determined by the glass, quinhydrone, or hydrogen electrodes with an accuracy that is within experimental error. With the use of the antimony electrode the results were from .307-.646 pH units higher than those obtained with the other electrodes. The effect of citric acid, lactic acid, and lactose upon the antimony electrode is emphasized and cited as possible reasons for the high values obtained with it.

The iodine content of milk as affected by feeding iodized dry milk.

ZAIDA M. HANFORD AND G. C. SUPPLEE, The Dry Milk Co. Research Laboratories, Bainbridge, N. Y., and L. T. WILSON, Walker-Gordon Lab. Company, Inc., Plainsboro, New Jersey. *Jour. Dy. Sci.* 17, p. 771, 1934.

This investigation was planned to show the iodine content of milk produced by cows fed under controlled conditions, the percentage recovery of iodine in milk, and the variations as affected by seasons and the stage of the lactation period.

In controlled experimental feeding tests it was found that the amount of iodine recovered in the milk is not directly proportional to the iodine consumed. The percentage recovered in the milk varied from about 5 to 20 and the recovery was always highest in the winter months. The kind of iodine fed did not seem to affect the efficiency of its utilization. These results were verified by analyses of milk produced in various parts of this country.

The iodine content of Wisconsin milk varied from 17 to 39 parts per billion, of New York milk from 13 to 39 parts, and of South Carolina milk from 47 to 94 parts per billion due to the higher iodine content of the cattle feeds.

Determination of minute amounts of copper in milk.

LILLIAN W. CONN, ARNOLD H. JOHNSON, H. A. TREBLER AND V. KARPENKO, National Dairy Prod. Co., Baltimore, Maryland. *Ind. Eng. Chem. (Anal. Ed.)* 7, No. 1, p. 15, Jan. 1935.

After a critical experimental study of four colorimetric methods the conclusion was reached that the chromotropic acid method can be eliminated because of the difficulty in distinguishing the end point, that the Biazzo thiocyanate-pyridin method is not sufficiently sensitive, and that the possibility of interference due to turbidity makes the xanthate method undesirable. However, the sulfide-carbamate method seemed the most desirable, it being the most sensitive and least subject to turbidity interferences. The separation of copper from other ash constituents was then subjected to critical study. Separation by use of hydrogen sulfide, and by microelectrolysis were studied, and though both were efficient the sulfide-carbamate method seemed to have several points in its favor. It is more accurate for samples of very low

copper content, more generally available to laboratories making routine analyses, and is less time-consuming.

During this study the procedure of ashing was also studied. The authors recommend platinum or quartz crucibles, previously extracted with sodium acetate, for the ashing. After evaporation of the sample to dryness, in the presence of 5 drops of acetic acid to prevent foaming, the sample should be ashed in a muffle at dull red heat (not over 565° C.). Using the carbamate method the copper content of a number of samples of milk and milk products were determined. The copper content of uncontaminated raw milk was found to range from 0.051–0.132 p.p.m., with an average of 0.077 p.p.m. for 18 samples. The copper content of 7 samples of pasteurized milk varied from 0.088–0.741 p.p.m. The copper content of 5 samples of dried milk varied from 1.37–17.15 p.p.m.

What every person should know about milk. L. C. FRANK, Pub. Health Reps. 49: 1505, Dec. 14, 1934.

Milk is stated to be an excellent food because (a) it is a natural food, (b) it is a cheap source of energy, (c) it is a good muscle builder, (d) it is a good bone and tooth builder, (e) it is a highly concentrated food, (f) it is an excellent source of vitamins A and G, and (g) it is highly digestible.

A quart of milk a day for normal children and a pint of milk a day for normal adults is advised, but all milk consumed should have been produced in a sanitary manner and then pasteurized in order to prevent the transmission of communicable diseases, which may be spread by contaminated milk supplies.

Consumers are urged to ascertain whether their local milk ordinances are equivalent to the uniform milk ordinance recommended by the United States Public Health Service and to insist upon certified or Grade A pasteurized milk.

Reprints may be secured from the United States Public Health Service, Washington, D. C.

Determination of available chlorine in hypochlorite solutions by direct titration with sodium thiosulphate. VIRGIL A. WILSON, Montana Livestock Sanitary Board, Helena, Montana. Ind. Eng. Chem. (Anal. Ed.) 7, No. 1, p. 44, Jan. 1935.

It has been found that the titration of hypochlorites with sodium thiosulphate is greatly influenced by the acidity of the solution. In an acetic acid solution the thiosulphate is oxidized completely to the sulphate and eight equivalents of chlorine are used per mole of the reagent. The modified procedure is used which is as follows:

Reagents required: 0.1 N sodium thiosulphate, starch-potassium iodide paper, and dilute acetic acid (10 per cent glacial acetic).

Preparation of 0.1 N sodium thiosulphate solution.—This solution is prepared by dissolving slightly over 3.1025 grams of the crystallized salt per litre of solution and adjusting the concentration so that it reacts with equivalent volumes of an iodide solution containing 1.5865 grams of pure iodine per litre of solution. The solution is then 0.1 N to chlorine when used for titrating an acetic acid solution of a hypochlorite and is 0.0125 N to iodine.

Method: The hypochlorite is diluted with water to contain approximately 0.1 per cent of available chlorine. Fifty cubic centimeters of this solution are pipetted into an Erlenmeyer flask and dilute acetic acid is added until a drop of the solution, when taken out on a glass rod, shows an acid reaction to litmus before the litmus is completely bleached. The thiosulphate solution is then run into the hypochlorite solution from a buret, a few cubic centimeters at a time, until a drop of the reacting solution fails to give a chlorine reaction with starch-potassium iodide paper. A second or third titration may be necessary in order to obtain the exact end point. The concentration of available chlorine in the original hypochlorite is then calculated from the amount of dilution and the volume of sodium thiosulphate used.

A contribution to the study of casein. CH. PORCHER, H. VOLKINGER, AND M. BRIGANDO, l'École Vétérinaire, Lyon, France. *LeLait* 14: 1041, Dec. 1934.

A study was made of the absorption of ultra-violet light by proteins and amino acids. Dehere had found an absorption band in the region of 2770 Å in the presence of tyrosins, tryptophane and phenylalanine. In a study of casein and paracasein and the partially hydrolyzed protein the authors did not find the absorption band reported by Dehere. Colorimetric and spectrographic studies indicate that there is no tyrosine, tryptophane, or phenylalanine in the soluble fraction, the hydrolysate. Cysteine was found present.

Picric acid in milk and its detection. M. LAGRANGE-FRANCES. *LeLait* 14: 817, Sept.-Oct. 1934.

The feeding of picric acid to cows results in the production of milk of a rich yellow color. There is no evident change in odor, taste, acidity, or other normal characteristics of the milk.

To detect this fraudulent practice the following method has been developed since the Pupeau-Mithonard reaction for picric acid is not applicable in this case. To 25 cc. of milk, add 50 cc. of 0.35 per cent copper sulfate solution, 5 cc. of water, and 50 cc. of freshly prepared lime water. Shake frequently during the period of 1 hour, filter, evaporate to about 100 cc. and filter, pour off 50 cc. of the filtrate and add 5 cc. of a mixture of 1 part ether and 2 parts chloroform. Shake and remove the chloroform layer. To 1 cc. of the chloroform solution add 10 drops of ammonia, 10 drops of water, shake, allow to settle. Add 0.5 cc. of Pupeau-Mithonard solution. A red

ring at the liquid junction indicates the presence of picric acid. Pieramic acid does not give the test.

A study of the factors influencing the Hill Curd test. W. J. CAULFIELD AND W. H. RIDDELL, Kansas Agr. Exp. Station, Manhattan, Kansas. JOURNAL OF DAIRY SCIENCE, Vol. 17, No. 12, p. 791, Dec. 1934.

In view of the extensive use of the Hill Curd test the present investigation was undertaken to determine the variation in results due to modifications in the technique of making the test.

An average of 12 tests on each of 4 different samples of milk by 3 different operators gave a difference of 3.6 grams between the different operators. This difference was not considered significant. A variation in the setting temperature from 30 to 40° C. (86 to 104° F.) changed the curd test from 39.1 to 70.3 grams. When the time interval between the adding of the coagulant and making the test was increased from 8 to 13 minutes the curd tension increased 6.5 grams for soft curd milk and 13.7 grams for hard curd milk. A reduction in the amount of pepsin, pepsin-calcium chloride solution, or calcium chloride below that specified in the directions for making the Hill Curd test increased the curd tension.

Oxidative changes of milk and dairy products. The oily tallowy taste. M. A. GONDOS. LeLait 14: 25-30, 1934.

Oxidation of the fat in dairy products is the cause of the tallowy odor and taste. The factors which accelerate the development of tallowiness are a high content of unsaturated acids, presence of metals which catalyze the activity of the oleinase and the absence of reducing substances which act as anti-oxidants. Elimination of press cake from the feed reduces the unsaturated acid content of the fat, and thus eliminates one factor. Fresh hay increases the anti-oxidants normally present, while pasteurization may destroy the oleinase. The use of anti-oxidants and bacteria having a reducing tendency as preservatives are advocated.

Mechanical refrigeration. E. H. PARFITT, Purdue University, Lafayette, Indiana. 22nd Ann. Rept. Internat. Assn. Dairy and Milk Inspectors, pp.108-119, 1934.

In a study of the cost of electrical refrigeration under various conditions, it was found that milk cooled in a dry box required 0.064 kw. hr. of current per 100 pounds per degree F., whereas the electrical consumption in a wet box cooler was 0.041 kw. hr. The heat losses in 24 hours per square foot per degree F. differential varied from 4.24 to 2.13 B.T.U. in the five insulated tanks used. Precooling the milk over a surface cooler to 70° F. appreciably reduced the current consumption, although no difference could be observed in the retardation of bacterial growth in split samples of milk, one of which was precooled, and the other not precooled. Agitation of the liquid cooling

medium in the wet type of collar increased the efficiency of cooling the milk, although no marked difference was noted in the retardation of bacterial growth.

Milk price control in New York State. KENNETH FEE, Director Milk Control Board, Albany, N. Y. 22nd Ann. Rept. Internat. Assn. Dairy and Milk Inspectors, pp. 191-203, 1934

On the approximately 75,000 dairy farms in New York state, there are 1,400,000 cows producing 5,500,000,000 pounds of milk per year. The number of cows has decreased and increased in 16-year cycles, and at the present time the cow population is about equal to that of 50 years ago. Approximately 50 per cent of the milk produced in New York is used in fluid form, 25 per cent in the form of cream, and 25 per cent for other dairy products such as butter, condensed milk, cheese and ice cream

As a result of the disparity between the rate of decline in the prices paid to producers, and the decline in the prices which the consumer had to pay for dairy products, a special legislative committee was appointed for investigation. From the findings of this committee has come a dairy law setting up a Milk Control Board which is declared to be the instrumentality of the state to supervise and regulate the entire dairy industry of New York state, including production, transportation, manufacture, storage, distribution, delivery and sale of milk and milk products. This Board is empowered to fix the minimum prices to be paid by milk dealers to producers, and makes it unlawful to buy or sell at any price less, or more, than such price or prices as shall be applicable to the particular transaction. No devices such as discounts, rebates, free service, advertising allowances, combined prices of milk with other commodities, service or services, etc., may be employed to defeat the purpose of this legislation.

The fluid milk industry in Europe. H. A. BENDIXEN, Dairy Dept., State College of Washington, Pullman, Washington. Milk Dealer, Vol. 24, No. 4, p. 34, January 1935.

The author discusses some of the interesting points of the fluid milk industry of England and Germany which were observed during a 15 months' visit to Europe.

Milk soluble sodium alginate as a suspending agent in chocolate milk. PAUL H. CATE. Milk Dealer, Vol. 24, No. 4, p. 74, January 1934.

The use of sodium alginate in the form of a dry, odorless and tasteless powder, as a stabilizer in the preparation of chocolate milk is discussed. It may be dissolved directly in hot milk, while the former sodium alginate used had to be made into a syrup.

Research on the preparation of Kefir milk. l'Ecole Veterinaire, Lyon, France. LeLait 14: 819, Sept.-Oct. 1934.

Modifications of the method of Dimitrieff are employed:

(1) Two to 40 grams of fresh grain per litre of milk are added, the milk held at 15–20° C. (59–68° F.) and shaken every 2–3 hours during the first 24 hours. The grains are then filtered off and fermentation by the young kefir allowed to continue. If held at room temperature it will keep for two days and at 0° C. (32° F.) for 8 days.

(2) Utilizing the mother of kefir: The fresh grains are placed in 40–50 times their weight of boiled milk, cooled to 15–20° C. After 24 hours the grains are removed from the creamy growth. This starter is mixed with 4 parts of cooled, boiled milk and held at 15–20° C. with shaking at 2–3 hour intervals. After one day incubation mild kefir milk, at the end of 2 days the average kefir milk, and after 3 days strong kefir milk 1.34 per cent alcohol content, results. For the preparation of a mild kefir milk 1 part of the previously described starter may be used with 5 to 10 parts of milk.

The effect of milk upon metals and metals upon milk. B. H. WHITFIELD, H. P. DAVIS, AND P. A. DOWNS. *Milk Dealer*, Vol. 24, Nos. 2, 3, 4, pp. 34, 40, 42, Nov. and Dec. 1934 and January 1935.

Experiments were conducted to determine the effect of copper, nickel, aluminum 3S, Inconel, and Allegheny metal upon milk under different atmospheric conditions and at different temperatures, and the effect of the milk upon the metals.

The experimental units were constructed of fiber, the parts coming into contact with the milk being coated with a sanitary baking lacquer.

Milk from Holstein cows was used, being milked by hand into enameled pails, cooled to 60° F., and held at 55 to 60° F. until used, a period of not more than four hours. Chemical and bacteriological analyses were made on the milk. Five hundred cubic centimeters of it were used per unit, being tempered for 30 minutes in the surrounding water bath before beginning the temperature and atmospheric treatments.

The various metal strips, properly prepared, were exposed to milk at 60° F. and at 144° F. for periods of one-half, two, and four hours, under three atmospheric conditions of air, oxygen and carbon dioxide.

Copper and nickel were the only metals that corroded. The weight losses of these metals was appreciable being greater at 144° F. than at 60° F. under the different atmospheric conditions. The weight losses of the other metals were all within the limits of experimental error.

At 144° F., an atmosphere of oxygen caused the greatest corrosion, air next, and carbon dioxide the least. The rate of corrosion varies with the amount of surface per unit volume of milk that is exposed to the atmosphere.

Copper was brightened and nickel was darkened by the exposures to the milk. The intensity of this discoloration was increased by oxygen and by longer time exposure. It was decreased by an atmosphere of carbon dioxide.

Copper always affected the flavor of the milk. Nickel produced a metallic flavor only occasionally and then only when the corrosion was great. The flavor was not affected by the other metals used.

Contact with metals did not change the acidity, pH, chloride or lactose content, or the bacterial count of the milk. A greenish discoloration was noticed in the milk, more from copper than from nickel, and more at 144° F. than at 60° F.

The holding of milk at 55° to 60° F. for 15 hours had no effect on the corrosion rate of nickel at 144° F. under an atmosphere of air. Illustrations of the experimental equipment are shown.

Effect of the udder on quality of milk. M. J. PRUCHA, University of Illinois, Urbana, Ill. 22nd Ann. Rept. of Internat. Assn. Dairy and Milk Inspectors, pp. 81-84, 1934.

Milk samples collected from each quarter of 1800 cows in 250 herds were examined by the Standard plate count, the methylene blue reduction test, and the direct count method.

Four per cent of the cows gave milk in one or more quarters showing 10,000 or more bacteria per cc. by the plate method. Udders with pathological disturbances, frequently gave milk showing from 10,000 to 50,000 bacteria per cc. Occasionally the milk from diseased quarters had a very low count, in a number of instances less than 100 per cc. The conclusion is drawn that high bacterial counts on freshly drawn milk indicate some pathological condition of the udder.

Twenty-two per cent of the cows gave milk in one or more quarters which reduced methylene blue in less than 5.5 hours, however, in a few instances milk which was decidedly gargety failed to reduce methylene blue in 5.5 hours. It is roughly estimated that about 75 per cent of the udders having some pathological condition were detected by the methylene blue test.

Normal milk was arbitrarily defined as milk containing less than 2,000,000 cells per cc. and no detectable streptococci or staphylococci. In only 1.1 per cent of the samples was it possible to detect streptococci or staphylococci in the milk by the microscope. However, there were 31 per cent of the cows, which gave milk containing more than 2,000,000 cells per cc. After correlating the observations in the herds and the laboratory tests, the author concludes that cells in excess of 2,000,000 per cc. indicate a pathological condition of the udder, and that the milk should not be sold for fluid consumption.

Streptococci in milk. W. D. FROST AND MILDRED A. ENGELBRECHT, University of Wisconsin, Madison, Wisconsin. 22nd Ann. Rept. Internat. Assn. Dairy and Milk Inspectors, pp. 85-104, 1934.

In a study of the streptococci in milk, extending over a period of eight years, 1825 samples from individual cows and 10,621 samples of mixed milk

from groups of 10 cows each have been examined. The study has included the isolation, differentiation, and identification of the types of streptococci present. The authors have found hemolytic streptococci in approximately 47 per cent of the group samples. In the total 12,446 samples examined, *Streptococcus pyogenes* was found 18 times, *S. epidermis* 10 times, *S. mastitidis* 654 times, *S. infrequens* 573 times, and *S. asalignus* 145 times. The authors believe the non-hemolytic group of streptococci are of more importance as a cause of sub-clinical bovine mastitis than other streptococci, and they suggest that the strains very commonly found should be classified as *S. mitis*, *S. faecalis*, and *S. salivarius*. It is concluded, that by regular examination, it is easily possible to give the same assurance to milk that pasteurization affords. It is suggested that milks be classified as "protected" and "unprotected" rather than as "pasteurized" and "raw." Under "protected" milk should be included certified and pasteurized milk, and under "unprotected" should be the ordinary raw milk.

A contribution to the study of the acidity of abnormal milk. R. VUILLAUME, *LeLait* 14: 13-25, 1934.

The author finds that milk from cows having mastitis has a decreased titratable acidity and an increased pH, and coagulates with difficulty or not at all when rennet is added. The rennet coagulation can be restored by addition of CaCl_2 or CO_2 . The colostrum and strippings from cows having mastitis were also studied.

Effective milk control. HENRY C. BECKER, Chicago Board of Health. Chicago, Illinois. 22nd Ann. Rept. Internat. Assn. Dairy and Milk Inspectors, pp. 173-186, 1934.

The effectiveness of the milk control program in various cities in the United States, is reflected in the reduction in the numbers of cases and of deaths from those diseases which are frequently milk-borne, such as diarrhea, enteritis, typhoid fever, septic sore throat, tuberculosis and many others. The necessity not only for continuation but enlargement of the milk control programs is emphasized by the fact, that from 30 to 50 definitely milk-borne epidemics occur in this country each year. It is not only important that effective legislation be enacted, but that effective enforcement be prosecuted.

The elimination of the personal factor in the operation of pasteurizing machinery, by installation of automatically operating devices now occupies one of the major activities of the Chicago department. Effective results have been obtained in plant and dairy farm inspections, by instituting the plan of taking photographs for permanent records of unsanitary conditions observed.

The improvement in the tuberculosis eradication program is shown by the fact that only 17 counties in the United States were accredited in 1923,

whereas today over 50 per cent of the 3,073 counties are accredited. There are 347 American cities which have adopted regulations requiring compulsory testing of cattle for tuberculosis.

Although the large cities must necessarily obtain milk from a very large milk shed involving as many as 23,000 herds for Chicago, and millions of gallons of milk daily, effective milk control programs have resulted in the total absence of milk-borne epidemics for Chicago in several years, and New York has had but one milk-borne epidemic in the past 17 years.

An important aspect of the Chicago milk control program is the requirements for washing and sterilizing of milk bottles. Bottles must be subjected to at least 1.6 per cent solution sodium hydroxide with a thermal exposure of at least 120° F. for not less than five minutes. The bottle must then be heated or sterilized with chlorine solution containing not less than 35 parts per million available chlorine. Bacteriological tests on bottles must not show a residual count in excess of one organism per 2 cc. of bottle capacity.

Need for uniformity in milk laws and regulations. A symposium. 22nd Ann. Rept. Internat. Assn. Dairy and Milk Inspectors, pp. 282-295, 1934.

Within the State: PAUL B. BROOKS, New York State Health Dept., Albany.

A committee investigation of the milk regulations of 60 cities in New York State showed a great lack of uniformity. In 18 cities, regulations were found which could be classified as either undesirable or not of sufficient importance to justify their inclusion in an ordinance. In many instances, regulations have been inserted in the health ordinance which are essentially trade regulations and have no bearing on public health. Uniformity based on essential requirements is to the interest of the milk industry as whole and of the public.

Between the States: J. J. REGAN, Dairymen's League Cooperative Assn., New York City.

The lack of uniformity in the milk regulations of various states creates chaotic, and in many instances, ridiculous conditions attending the milk supply of large cities located near the junction of two or more state lines.

The five states comprising the milk shed of the metropolitan area of New York City are, New York, Pennsylvania, New Jersey, and parts of Vermont and Connecticut. Within this area there are approximately 700 milk plants receiving milk from approximately 100,000 dairy farms. The majority of the 700 producing units are owned by a few large concerns. Due to seasonal shifts in population, it is frequently necessary to direct the products from one unit to another. This in turn necessitates that the milk plants in one part of the milk shed drawing upon dairy farmers in a certain state must meet the requirements for sale of dairy products in New

York or New Jersey as the case may be. Specific examples are cited in which it was necessary for one plant to submit to regulations by seven inspectors representing as many boards of health. Requirements of the different boards not only vary in number, but considerable disparity exists between the interpretation of identical regulations. The conclusion is reached that milk regulations for large cities should be designed for the entire milk shed rather than subdivided by imaginary state lines.

Is a single grade of pasteurized milk sufficient? Affirmative: GEORGE WEST, Dept. of Health, Rochester, N. Y. **Negative:** LESLIE FRANK, U. S. Public Health Service, Washington, D. C. 22nd Ann. Rept. Internat. Assn. Dairy and Milk Inspectors, pp. 238-257, 1934.

Affirmative: The single, true public health grade for pasteurized milk provides a maximum degree of safety by concentrating the time of control officials on sub-standard milk. It encourages greater milk consumption on a true quality basis. It secures more effective cooperation of the dairy industry because it simplifies the production and pasteurization requirements. The use of a single grading system is applicable to small, medium, and large communities. The function of the health control officials is to eliminate the sale of unsafe milk, which means that the poorest grade permitted by any multi-grade system must be safe. Any attempt to build up, define, and identify better grades is essentially a marketing problem, and it should be supported by the industry rather than the health department.

Negative: In the construction of an ordinance to meet the needs of a variety of conditions to be met in many communities, generalizations must be recognized which are not involved in preparing an ordinance for a single community. Regardless of what may be the requirements in an ordinance, the health officer is repeatedly confronted with failures to comply with the details. In some instances, these requirements, although important, are of a sufficiently technical nature as to be difficult to defend before a non-technically trained court or board. If an ordinance providing only a single grade of pasteurized milk is in force, the health officer has only the weapon of revocation of permit and elimination from sale; if multi-grades are recognized, he has first the milder weapon of degrading the output of the plant, and has the most drastic revocation weapon in reserve.

What are the essential requirements for clean, safe milk for pasteurization? A symposium. 22nd Ann. Rept. Internat. Assn. Dairy and Milk Inspectors, pp. 258-281, 1934.

The Herd: VINCENT C. MOYER, Supplee-Wills-Jones Co., Philadelphia, Pa.

The importance of a clean healthy herd for a safe pasteurized milk supply cannot be overemphasized. Tuberculin testing, blood testing for Bang's disease, periodic examination for udder infections, general physical examination of the cows by a competent veterinarian according to the Standard

procedure set up by the American Veterinary Medical Association is urgently recommended not only as a preventative, but as an agency for maintaining public favor of pasteurized milk.

The Farm: J. M. LESCURE, Baltimore Health Department.

In drawing up regulations for the dairy farm, it is very important to differentiate between those requirements which are essential, and those which are desirable. In the regulation of the milk supply of Baltimore, the following eight items of equipment are regarded as essential: Chlorine sterilizing solution, wash buckets and cloths, milk cans of approved design, small-top pails, floating thermometers, drain rack for utensils, scrub brushes, and an abundant supply of hot water. There are five rules regarding the handling of the milk as follows: (1) All cans and other utensils must be rinsed in a chlorine solution (100 p.p.m.) just before use; (2) before milking, cows' udders and flanks must be washed; (3) cool milk to 60° F.; (4) store evening's milk so as to insure a maximum temperature of 60° F. until shipped; (5) clean all utensils immediately after use by rinsing with cold water, followed by scrubbing with warm alkali water, then rinse with scalding water, and allow to drain and dry.

The Receiving Station: GEORGE GRIM, Ardmore, Pa.

The function of the receiving station is to cool the milk without delay, and to wash and sterilize the milk cans for the dairy farmer. The stations must be located near the center of the dairy population in order to function properly by minimizing the delay in cooling the milk. A survey of milk receiving stations revealed many common faults.

The Milk Handler: VERNE E. HARVEY, State Health Dept., Indianapolis.

Each milk handler should have properly developed habits of cleanliness, and in addition, sufficient knowledge to rationalize those habits. The milker should wear freshly laundered, clean clothing, clean shoes, a cap to cover his hair; he should carefully wash his hands and rinse them in sterilizing solution before milking. He should not use tobacco during or, for some period before milking due to the inevitable tendency for smokers to place their hands to their mouths, and for those who chew to expectorate frequently. The milker should have a sufficient familiarity with bovine diseases to recognize and report suspicious symptoms. All milk handlers should be examined annually to detect those having active, or chronic diseases or those who may be carriers of disease germs.

Report of committee on methods of improving milk supplies in small communities. C. A. ABLE. 22nd Ann. Rept. Internat. Assn. Dairy and Milk Inspectors, pp. 290-305, 1934.

Detailed information has been accumulated by the committee concerning the milk control program in effect in 64 committees of less than 10,000

population, located in six widely separated states. In none of these 64 communities is a full-time milk inspector employed solely for milk control. The milk control work is handled either by (1) municipal officials, (2) health department personnel, or (3) part-time milk inspector. The committee found that it was not desirable to employ a practicing veterinarian as a part-time milk inspector, due to inevitable conflict between official and professional duties.

A majority of the committee under 10,000 population have continued milk inspection programs in spirit of reduced revenues. Milk control work was found to be financed by one of the following six methods: (a) Direct appropriation from city treasury, (b) as an activity of the health department with or without earmarked appropriation, (c) by combination with meat inspection, (d) by cooperation of two or more communities, (e) by direct taxation of the dairy industry either on a basis of gallonage or cow population, (f) by a combination of any two or more of these methods.

Report of committee on dairy farm methods. THOMAS J. STRAUCH. 22nd Ann. Rept. Internat. Assn. Dairy and Milk Inspectors, pp. 296-297, 1934.

This committee has drawn up a list of requirements which are deemed essential to the production of dairy products of high quality. (1) The utensils must receive proper care. (2) Every precaution must be exercised to prevent flavor defects, and odors of milk due to the surroundings of the milk or the feed of the cows. (3) Milk should be used only from clean cows known to be free from disease. (4) Only rust-free, smoothly soldered utensils should be used. (5) Milk should be cooled immediately at the farm to a temperature of 45° F. or lower.

The quality of milk pasteurized by high-temperature, short-time and 30-minute holding methods. M. W. YALE, New York Agr. Exp. Station, Geneva, N. Y. 22nd Ann. Rept. Internat. Assn. Dairy and Milk Inspectors, pp. 62-69, 1934.

At the present time, at least six types of short-time pasteurizers are in use in this country. In each case, temperatures of not less than 160° F. for periods of not less than 15 seconds are employed. Although, the short-time method of pasteurization presents several disadvantages, its ultimate acceptance depends upon proof that this method will provide milk that is equally as good and as safe as the well established holding method provides. In this work, comparisons were made of the two methods for the relative destruction of cream layer, flavor, bacterial reduction, destruction of the *Escherichia-Aerobacter* group, development of thermophilic bacteria, and the destruction of pathogenic bacteria. None of the evidence collected showed any significant difference between the two methods in the effect on the cream layer, no detectable difference in flavor, reduction of bacterial

counts, or destruction of *Escherichia-Aerobacter* types or pathogenic types. There was a definitely lesser tendency for thermophilic organisms to develop in the milk pasteurized by the short-time method.

Some practical conclusions drawn from eight years' study of mammitis in Europe and North America. J. M. ROSELL, Dept. of Bact., University of Montreal, Montreal, Canada. *LeLait* 14: 1050, Dec. 1934.

A short review of the studies on mammitis. Through the sediment hydrogen-ion catalase, and chloride contents of the milk, mammitis may be detected. Its spread may be checked by the use of hygienic and prophylactic measures and especially through the segregation of infected animals. Repeated vaccination also seems to have proved an efficient prophylactic measure. Very satisfactory results have been obtained by 3 to 5 injection of a vaccine at intervals of seven days.

***E. coli* in mastitis with accompanying changes in milk composition.** F. R. SMITH AND J. L. HENDERSON, Dairy Ind. Division, Univ. of California, Davis, California. *JOURNAL OF DAIRY SCIENCE*, Vol. 17, No 12, p. 799, Dec. 1934.

Samples of milk were collected from a cow both before and after a severe case of mastitis. It was definitely proved that the infection was caused by a toxic strain of *Escherichia coli*. The organism was highly toxic to guinea-pigs. Various chemical tests in the milk such as pH, lactose and chloride content showed mastitis. These observations substantiate some work of earlier investigators that mastitis may be caused by *Escherichia coli*.

A critical clinical study of various infant foods. III. Fresh whole milk modification without fat deficiency. A. G. DE SANCTIS, J. D. CRAIG, AND H. L. FALES. *Jour. Pediat.*, Jan. 1934.

An adequate caloric intake distributed in a correct proportion of fat, protein and carbohydrate is essential for successful artificial infant feeding. The authors discuss a new powdered product for milk modification which has been designed to provide the needed, additional calories partly as milk fat, and partly as carbohydrate. This modifier also contains iron and vitamins A and B in quantities larger than are usually provided in most milk mixtures. Its constituents include fresh whole milk, fresh cream, refined lactose, whole wheat flour and iron.

A clinical study of two groups of infants, receiving different amounts of the modifier in fresh milk and water formulas is reported. The group receiving a lower fat, and higher carbohydrate and protein modifier grew better than the higher fat, lower protein and carbohydrate babies, and compared favorably with a control group receiving a maltose dextrin carbohydrate modification. Antiscorbutic and antirachitic agents were given routinely.

Nutrition and child-bearing. E. MELLANBY. *Lancet*, Nov. 18, 1933.

That the diet of the pregnant woman has a lasting effect not only on her own health, but also on that of her child, is pointed out by this investigator, who reviews and discusses a number of studies showing a close relationship between nutrition during childbirth and the later development of the child. Pelvic deformities which are an important factor in deaths due to childbirth are themselves largely the result of malnutrition in infancy, due to an inadequate diet on the part of the mother.

The author discusses specific injuries to mother and child caused by diets deficient in vitamins A and D, calcium, phosphorus, iodine and iron. If the diet of every pregnant woman included a quart of milk, two green vegetables, fresh fruit, one or two eggs daily, as well as fish and calf's liver at least once a week, and two tablespoonsful of cod liver oil daily, the number of deaths as a result of childbirth would be appreciably reduced.

Retardation of dental caries in outpatients of a dental infirmary. Preliminary study. P. R. HOWE, R. L. WHITE AND M. RABINE. *Am. J. Dis. Child*, Nov. 1933.

This study was undertaken to determine the practicability of dietary measures in the control of dental caries in children who are not under institutional care. The results indicate that this is entirely possible. Of 132 children studied, 104 cooperated and 28 did not. The daily diet recommended included one quart of milk, one raw vegetable, two cooked vegetables, two fruits, one egg, meat or fish five times a week, and butter on vegetables and bread. Cereals were kept at a minimum constant with energy requirements as their acid ash was felt to be harmful.

Cod liver oil was given when recommended by the pediatrician. Over a period of 1.6 years an average reduction of dental caries of 79.21 per cent was observed in the 104 cooperating patients. An increase of 12.97 per cent occurred in the non-cooperating group. The authors conclude that a program of dietary control can be carried out by the dental practitioner, with a knowledge of nutrition, and the ability to interest his patients in dietary improvement.

Coagulated milk and its dietary uses. F. C. SCHLUTZ. *Jour. Am. Diet. Assn.*, Jan. 1934.

Coagulated milks such as junket or milk, to which rennin has been added, offer a valuable dietary aid not only in the feeding of infants but in many adult cases, where anorexia is present or where a highly digestible food, rich in nutritive value, is required. The physiologic aspects of coagulated milk are discussed briefly, showing how this treatment of milk renders this important food more digestible.

Nutritive value of boiled and raw milk in infant feeding. N. MORRIS AND S. GRAHAM. *Lancet*, Dec. 9, 1933.

Metabolism studies of two infants, to compare the effect of raw and boiled milk on the retention of calcium, phosphorus, nitrogen and fat, showed that higher retention occurred when boiled milk was given. Each infant received raw milk for seven days, and then boiled milk for a similar period. The authors state in conclusion "as far as these results go there is no evidence to support the idea that the boiling of milk interferes with its usefulness as a food for infants."

Iodine and its relation to health—A review. M. C. MOORE AND H. W. MOSELEY. *New Orleans Med. and Surg. Jour.*, Jan. 1934.

Although iodine as an element has been discovered only a little over a century, the value of sea foods and seaweeds in the prevention and cure of goiter has been recognized for thousands of years. These are known to contain liberal amounts of iodine. Milk, eggs and other foods also supply iodine, although the amount present in any food varies with the location in which it is produced, and is dependent on the amount of iodine present in the soil, air and water. Iodine is essential for normal growth, and lack of it is responsible for a number of ailments, of which goiter and thyroid deficiency are the most generally recognized. The iodine content of milk can be increased by special feeding of the producing cattle.

A new phase of vitamin D milk. F. B. MACKENZIE. *Northwest Medicine*, Jan. 1934.

The outstanding value in the diets of children and adults as a source of calcium, makes milk the most logical one to which vitamin D may be added. Of the three methods used, addition of a concentrate, direct irradiation of the milk, and supplementing the diet of the cow with irradiated yeast, the first is the least practical, and the second and third are the methods most widely employed.

The work of outstanding authorities shows that the average American dietary is deficient in calcium, that high infant and maternal mortality rates are largely attributable to a lack of vitamin D and an inadequate diet, and that where milk and vitamin D have been given in sufficient quantities a marked improvement in health and development is invariably observed. Rickets is, of course, the outstanding example of vitamin D deficiency, but tuberculosis, tetany, dental caries and a number of other diseases are frequently traceable to a deficiency of calcium and vitamin D. Although toxic conditions may arise from overdosage with vitamin D, there is no danger of such an occurrence when vitamin D milk is used. The minimum dosage for the best results is a question now being widely studied. The availability of vitamin D milk is rapidly spreading, and all physicians should be acquainted with the facts regarding its use.

Calcium and nutrition. A. R. BERNHEIM. *Health Examiner*, 4: 8, Dec. 1934.

In order to secure the 0.7 gram of calcium required daily by adults as well as by children for optimum health, one quart of milk or one quarter pound of cheese should be included in the average well-balanced diet. Calcium absorption is adequate only when the intestinal reaction is acid, a condition which reaches its height several hours after a meal. For this reason milk should be taken with meals, which should be at five hour intervals, and nothing should be eaten between meals.

"The use of an adequate calcium regimen by patients suffering from a number of apparently unrelated disorders, such as peripheral vascular diseases, peptic ulcer, osteitis deformans, and various forms of allergy, is followed," writes the author in italics, "in a majority of the cases by marked improvement in symptoms, while with many normal individuals the use of this regimen makes for the difference between 'passable' and 'buoyant' health."

For those who like milk, the author advocates a quart of milk a day, one pint to be taken at each of two meals. For those who like only small amounts of milk, one-half pint at one meal, another one-half pint, or cheese at the second meal, and supplementary calcium salts, are recommended. For those who do not like milk, calcium salts must be employed. The diet in all cases should also include meat or fish once a day, vegetables and fruit, especially orange juice and tomato juice, and some form of vitamin D.

Vitamins and paradentosis. J. A. MARSHALL. *Dental Survey*, 11: 26, Jan. 1935.

That diseases and abnormalities of the gum tissue may occur as a result of dietary deficiency in one or more of the vitamins has been shown by the investigators. Although certain of these conditions are not curable by dietary correction, their progress may be arrested. If these facts are true, the dentist, the obstetrician and the pediatrician must cooperate to prevent dental disease. The value of dairy products, fresh fruits and vegetables, and meat is emphasized for all children, and for pregnant and nursing mothers. Dietary experiments upon children indicate that calcium and phosphorus are retained rather than excreted when individuals are on a high milk diet.

Nutrition, Vitamin D milk. J. A. TOBEY. *Medical Times and L. I. Med. Jour.* 63: 15, Jan. 1935.

The author reviews the extensive experimental work which has been done in the last few years demonstrating the value of vitamin D milks (produced either by direct irradiation of the milk or by the inclusion of irradiated yeast in the cow's diet) in the prevention, control and cure of rickets in infants. Although further study is necessary on the technical control of vitamin D

milk, it is now generally accepted by the medical profession that these types of milks have an important place in the control and eradication of rickets. Health officers must follow with suitable regulations controlling the production and distribution of these important products.

Milk receiving antirachitic potency by the addition of a cod liver oil concentrate has not been so widely studied as have the irradiated and "yeast" milks. One difficulty in the development of this type of antirachitic milk has been the prohibition in many communities of the addition of any foreign substance to milk produced commercially. Irradiated and "yeast" milks do not come under this category, but are natural or properly processed milks.

Milk utilization and its relation to nutrition. HELEN B THOMPSON, Prof. of Home Economics, Univ. of California, Los Angeles, California. *Milk Dealer*, Vol. 24, No. 4, p. 40, January 1935.

The author summarizes the newer scientific information in relation of milk to nutrition, and gives the results of some observations in connection with nutrition and dietetics in the schools of Los Angeles.

Many children do not consume the proper amount of milk because the adults with whom they are associated do not drink it, because mothers often think it is too expensive or that it displaces other equally important foods from the diet.

Milk agrees with children. In a study of the food habits of 118 boys and 99 girls in nursery and elementary schools, only one child gave an allergic response to a milk protein, and none showed any digestive disturbance from its use. Only one-fourth of the boys and girls up to 5 years of age were free from prejudices against foods other than milk, and between the ages of 5 and 10, two-thirds of the boys and half of the girls had learned to eat without protest any food offered. Correct eating, therefore, is attained by a learning process, and it should be the duty of parents and teachers to teach children to eat a varied and wholesome diet.

Milk is not too expensive for the low cost dietary. The evidence shows that milk and cereals together with vegetables and dried fruits give the best results in terms of essential nutrients for the money expended.

In March, 1934, in Los Angeles and surrounding cities, it was found that a dietary for three children and two adults could be purchased for 20 cents per person per day. This dietary for five included 5.62 pounds of fresh milk and 0.62 pounds of evaporated milk per day, and, for the month, 3.0 pounds of American cheese. These represented 28.4 per cent of the total expenditure for food, and supplied 66 per cent of the calcium, 35 per cent of the phosphorus, 10 per cent of the iron, and part of the vitamins for the entire dietary. No other foods could be selected to replace these values at the same cost, and it should be a matter of conscience rather than of devo-

tion to the dairy industry to teach the economic as well as the nutritive value of milk.

Cataract in rats fed on high lactose rations. HELEN S. MITCHELL AND WARREN M. DODGE, Battle Creek Sanitarium, Battle Creek, Michigan. Jour. Nutrition 9, No. 1, p. 1, Jan. 1935.

Various types of experimental cataracts reported do not seem to point to any common etiological causative factors, and their occurrence usually suggests some metabolic disturbance rather than some nutritional deficiency. These authors have found that bilateral cataracts occur in 68 per cent of the rats fed on a 70 per cent lactose ration, with advanced lens changes showing in 100 per cent of the animals. Rations containing lower quantities of lactose resulted in slower and less pronounced lens changes, and rations of starch, maltose, dextrin, or sucrose fed at a 70 per cent level produced no cataracts.

The calcium content of cataracteous eyes is approximately twice that of normal eyes. Furthermore, it has been shown by various authors that the feeding of lactose increases the calcium absorption from the intestinal tract. However, no direct correlation is made between these facts since rabbits and kittens on diets similar to those of the rats developed no lens abnormalities. It may also be probable that rats are peculiarly susceptible to cataract.

This latter fact and that the quantities fed would never be approached in any but laboratory diets, makes it impossible to apply the results to human or other species.

Notes on the standardization of vitamin D milk. E. V. MCCOLLUM. Dept. of Biochem., The Johns Hopkins University, Baltimore, Maryland. Milk Dealer, Vol. 24, No. 4, p. 32, January 1935.

The author discusses the methods of arriving at the potency to which milk should be standardized in respect to its vitamin D content. He states that the symbol D has had three distinct meanings since its introduction in 1929, but that at present 1 international unit of vitamin D equals 2.5 to 3.0 Steenbock units, with the value of 2.7 generally used.

The Steenbock unit is defined "as the total amount of vitamin D necessary to produce a narrow and continuous line of calcium deposits in the metaphysis of the distal ends of the radii and ulnae of standard rachitic rats under standard feeding conditions."

The potency of cod liver oil and viosterol and the standards associated with these products are discussed. The writer has been unable to find any convincing evidence that there is any basis for recommending different unitage of D for children on the basis of its source. No one has actually demonstrated any difference in the potency of vitamin D, whether provided as cod liver oil, viosterol, cod liver oil concentrate or irradiated milk.

No attempt should be made to render milk of high antirachitic potency to provide for prophylaxis in the case of all children, but only to afford protection to the well children, leaving to the physician the determination of the proper dosage for those who require more than the minimum amount of vitamin D for safeguarding their health.

The importance to child health of a suitable provision of vitamin D, and the fact that rickets of a mild grade is still of common occurrence, makes the vitaminization of milk highly desirable.

The nutritional value of milks—Raw vs. pasteurized and summer vs. winter. C. A. ELVEHJEM AND E. B. HART, Dept. of Agr. Chem., Univ. of Wisconsin, Madison, Wisconsin, and H. C. JACKSON AND K. G. WECKEL, Dept. of Dairy Industry, Univ. of Wisconsin, Madison, Wisconsin. JOURNAL OF DAIRY SCIENCE, Vol. 17, No. 12, p. 763, Dec. 1934.

In view of the fact that practically all previous experiments on the influence of pasteurization on the food value of milk have been based upon feeding milk not properly mineralized to support maximum growth, the authors have repeated these experiments. The milk was that received at the University dairy from 20 farms. One sample was taken before pasteurization, the other after pasteurization at 145° F for 30 minutes. The milks were then enriched with iron and copper, or with iron, copper, and manganese and fed as the sole diet of the rats.

The authors have concluded that, "Rats started on experiment in October and grown on mineralized raw milk and mineralized pasteurized milk showed no differences in growth or development over a period of 30 weeks. The average daily gains during the first six weeks for rats on mineralized raw milk were less for the animals started in April than those started in October. In April the rate of growth for rats on pasteurized milk was inferior to that obtained on raw milk.

"A decrease was observed in the daily rate of growth in male rats on mineralized milk from 4.19 gm. for milk produced in October to 3.32 gm. for milk produced in December to 2.45 gm. for milk produced in February. The decrease for male rats on pasteurized milk for the same periods was 3.90 to 1.96 and to 1.14 gm. The female rats showed some decrease in growth on winter milk but the impairment in growth during this period was not nearly as great as that observed in the case of the male rats.

"The kind of feed ingested by the cow has a greater effect upon the nutritive value of milk than does pasteurization.

"Pasteurization has practically no detrimental effect, as measured with rats, upon the nutritive value of a milk of high nutritive quality but may further decrease the value of a milk of low nutritive quality."

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ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

BUTTER

Effect of temperature, salt and acidity on growth of mould (*Oospora lactis*). H. MACY AND A. E. ANDERSON, Division of Dairy Husbandry, Univ. of Minn., St. Paul, Minnesota. National Butter and Cheese Jour. Vol. 25, No. 22, Nov. 25, 1934.

A study was made of the conditions affecting the growth of the mould (*Oospora lactis*), which is the most prevalent species found in milk and dairy products. Seven cultures were isolated from butter and their ability to grow on substrates containing varying amounts of salt, varying acidities, and at different temperatures was observed. The substances used were whey agar, and buttermilk obtained from the churning of sweet and sour cream.

Growth was extensive in controls on all media at 20° C. (68° F.), less luxuriant at 10° C. (50° F.) and 2° C. (35.6° F.), and entirely checked at -23° C. (9.4° F.). Low temperatures had no permanent effect on the viability of the cultures except when the pH of the whey agar was low.

The growth on whey agar was affected when the salt concentration exceeded 1 per cent and was entirely checked at 10 per cent; the growth on buttermilk was usually retarded at a salt concentration above 2.5 per cent and stopped at 10 per cent

The degree of acidity did not in itself have a very marked effect on the extent of growth. The combined effects of high salt concentration and low temperature and/or hydrogen ion concentration were noticeable.

CHEESE

Disturbances in the natural oxidation-reduction equilibrium of milk with special reference to the use of the dehydrated milks in the manufacture of cottage cheese. W. H. E. REED AND R. L. BROCK, Dairy Dept., Missouri Agr. Exp. Sta., Columbia, Missouri. Missouri Agr. Exp. Sta. Res. Bull. 216, July, 1934.

This bulletin is a technical study of certain phases of the use of dry milk in the manufacture of cottage cheese.

CONDENSED AND DRY MILK

Evaporated milk and beta lactose in infant feeding. SIMON SKOLE, Med. Rec. 139: 87, Jan. 17, 1934.

A group of 54 infants fed evaporated milk and beta lactose showed better growth and health than did a control group of 54 on ordinary fluid

milk and carbohydrate formulas. The uniform composition and highly digestible fat and protein of evaporated milk are important factors in the success of this form of milk as an infant food. Lactose, being the same carbohydrate as that which occurs in breast milk, is more slowly and more completely assimilated than are other carbohydrates, and fermentation occurs in the small intestine, thereby preserving the normal intestinal flora.

The group of infants receiving evaporated milk and beta lactose showed better weight gain, better tissue turgor, less constipation, and fewer gastro-intestinal upsets than did the control group. No case of rickets occurred in the evaporated milk group. The author suggests the superior nutrition of this group as an important factor in the prevention of rickets, possibly more important than the administration of any form of vitamin D.

The relation of dry skim milk to several of the physical and chemical properties of cream cheese. W. H. E. REID AND H. R. ALLEY, Dairy Dept., Missouri Agr. Exp. Sta., Columbia, Missouri Missouri Res Bull. 213, July, 1934.

This investigation deals with the manufacture of cream cheese by recently developed procedures with special reference to the use of dry skim-milk.

The use of evaporated milk in digestive disorders, particularly peptic ulcer. P. B. DAVIDSON, F. BIGURIA AND RUTH GUILD. Jour. Am. Diet. Assn., 9: 478, March, 1934.

The value of milk and cream in the treatment of gastro-intestinal disorders lies in their high nutritive value, their ability to inhibit gastric secretion, and their high acid-combining power

As a result of studies on peptic ulcer patients, in order to determine the comparative stimulating power of fluid milk, evaporated milk, diluted and undiluted, and milk with 20 per cent cream added, the authors conclude that undiluted evaporated milk and milk and cream are both less stimulating than diluted evaporated milk or fluid milk. The influence of all four forms of milk on gastric acidity and motility were found to be practically the same.

Evaporated milk in infant feeding. A clinical study of 400 cases. WARREN QUILLIAN. Jour. Fla. Med. Assn., 20: 291, Jan., 1934.

Evaporated milk and beta lactose formulas were given successfully to three groups of infants, and the results compared favorably with those observed in infants receiving other formulas. The uniformity of composition, superior digestibility, and simplicity of evaporated milk are important considerations, especially when the purity and safety of the fluid milk supply is questionable and the economic status and intelligence of the mother are not high. The first group of infants in a city clinic, the second

group of premature babies in a hospital and the third group taken from private practice also showed excellent growth and freedom from constipation and diarrhea after the formulas were properly adjusted. A total of 340 cases were involved.

MILK

The color imparted to coffee by cream treated in various ways. RANDALL WHITAKER. Res. Lab., National Dairy Prod. Corp., Baltimore, Maryland. Jour. Dairy Science Vol. 17, No. 10, p. 651, Oct., 1934.

It was observed by the author and reported by consumers that bottled sweet creams of competing companies varied in their ability to color coffee. A method of measuring the coloring power of cream in coffee was devised. It consisted in the preparation of a standard coffee solution prepared by swirling a cheese-cloth bag containing 22 pounds of medium ground coffee for 5 minutes in 5 gallons of water at 200° F. The coffee was then filtered and sterilized in 1 pint or 1 quart bottles for 25 minutes under 15 pounds steam pressure and stored at room temperature until required. In making the test 100 cc. of the coffee solution at 180–200° F. was poured into a white cup containing 10 cc. of the cream at 40–45° F. The color was then matched a standard golden yellow-brown of the Munsell system. If the color did not match the test was repeated using more or less cream until the desired shade was secured.

It was found that coffee cream in the Baltimore area required from 7.7 to 10.6 cc. to give the desired color while whipping cream required from 7.1 to 8.5 cc. Furthermore, cream from the same plant may vary from day to day. The amount of cream required to impart to coffee a given color decreased when the fat content increased (10.0 cc. for 20 per cent cream and 5.7 cc. for 40 per cent cream), when the solids-not-fat content increased (an additional one per cent of solids caused the required cream to decrease from 10.0 to 9.0 cc.) and when the cream was homogenized (this decrease was 0.6 cc. for cream homogenized at 400 pounds pressure).

Pasteurization of cream and aging had no effect upon the quantity required to develop a standard color in coffee. When cream was heat treated to 86° F. to increase its viscosity the amount required to give comparable colors in coffee was increased from 10.0 to 10.3 cc.

Some essentials in quality milk production. J. G. HARDENBURGH, Walker-Gordon Co., Plainsboro, N. J. Certified Milk Vol. 9, No. 102, 9–15, October, 1934.

During the past four decades, the dairy industry has made greater advances in this country than it has in most countries during the past four centuries. The production of good milk is the most complicated branch of the farming industry and requires a knowledge of animal husbandry,

of feeds and their utilization by the cow, of animal physiology, of the fundamental principles of hygiene as applied to the control of animal diseases, as well as of the sanitary requirements in the production of a highly perishable food.

The essential requirements for the efficient operation of a dairy business are becoming so much more and more technical that it is tending inevitably to centralize the production into fewer and larger units. Economic handling of a dairy herd demands that the herd be of sufficient size to support the overhead expense of adequate modern machinery and the expense involved in the selection and elimination of diseased animals. Farmers who are milking a few cows as a sideline cannot afford to follow the rigid schedule of sanitary control measures involving periodic examination of cows, and many other items prerequisite to adequate herd management.

Milk production per square mile offers interesting study. E. C. DAMROW, Damrow Brothers Co., Fond du Lac, Wisconsin. *National Butter and Cheese Jour.*, Vol. 25, No. 15, p. 14, Aug. 10, 1934.

The 100 leading milk producing counties in this country are listed, according to the United States Department of Commerce, Bureau of Census Report for 1930 (see accompanying table).

Out of the 100 counties listed in 12 states, Wisconsin has 37 counties, New York 23, California and Minnesota 10 each, Pennsylvania 8, Illinois 3, Iowa, Vermont, and Washington 2 each, and Massachusetts, Michigan and New Jersey 1 each.

Shaded maps of the states of Wisconsin and New York are presented.

The value of hand stripping after machine milking. JOHN L. WILSON AND C. Y. CANNON, Iowa Agr. Exp. Station, Ames, Iowa. *Jour. Dairy Science*, Vol. 17, No. 4, p. 331, April, 1934.

Stripping versus not stripping after machine milking was studied in a double reversal trial with 40-day periods. During periods in which the cows were stripped after the milking machine the production of milk and butterfat was 2.5 per cent greater than in periods in which stripping was omitted. Calculations show that not stripping resulted in the loss of 54 per cent of the milk and 27 per cent of the fat which would have been present in the strippings had the cows been stripped. The fat percentage in the milk was not influenced by omission of stripping.

Practices designed to replace hand stripping were only partially effective. Massaging the udder during the last two minutes the cows were being milked by the machine reduced the amount of strippings 33 per cent. Manipulation (pulling down) of the test cups during the last minute of milking caused a 55 per cent reduction in the amount of strippings.

The fat percentage of milk as affected by feeding fats to dairy cows.

NAT. N ALLEN, Div. of Dairy Husbandry, Univ. of Minn., St. Paul, Minn. Jour. Dairy Science Vol. 17, No. 5, p. 379, May, 1934.

The author has shown that the butter fat content of milk may be appreciably increased for short periods of time by feeding grain rations enriched with fat.

A survey of certified milks. DAVID WILBUR HORN. Lecturer in Hygiene, Hahnemann Medical College, Bryn Mawr, Pa. The Hahnemannian Monthly, Vol. LXIX, No. 6, p. 401, June, 1934

During the past 10 years the author has examined 2,248 samples of certified milk. The samples were purchased by health officers as the milk was being sold to customers or was being carried on delivery wagons. The samples were iced immediately and delivered to the laboratory. These samples were taken in the suburban area of Philadelphia. The samples were collected from 1923-1932 inclusive, with considerable monthly and yearly uniformity.

The bacterial counts made by the standard plate method were grouped on the basis of all counts in the hundreds, all counts in the thousands, etc., and these counts were then grouped by months.

There were 361 samples with counts below 1000, there were 1,578 samples with counts between 1,000 and 10,000, and 52 samples with counts above 100,000. Although many samples seemed to be rather high in count for this grade of milk, it should be borne in mind that 90 per cent of all samples contained not more than 10,000 colonies per cc. which is the standard for certified milk.

Analysis for butterfat showed that probably 95 per cent of all samples met the standard of an average of 4.0 per cent fat and a minimum of 3.5 per cent.

Based upon the usual laboratory tests there were a number of irregularities other than in bacterial counts and butterfat composition which were classified as follows:

Offence	Number of offences
Visible dirt	203
Skimming	142
Added water	2
Low total solids	3
Excessive leucocytes	9
Misbranding	4

Schardinger reaction on raw colostral milk and hygienic control of milk for consumption. A. HOUDINIER, Food Inspector at Nancy. Le Lait, 14, 468-78, 591-603, 1934.

The time of the Schardinger reaction varies with temperature and quantity of reagent used. Normal milk causes a reduction in 10 to 15 minutes at 40 to 65° F., while colostrum milk does not decolorize the methylene blue in 48 hours. Mixtures of colostrum and normal milk give a retarded action. This method may also be employed to detect high temperature pasteurization. High temperature pasteurization retards the reduction of methylene blue. The use of the Schardinger reaction for hygienic control is therefore of value where high pasteurization temperatures are not employed.

Studies on acidophilus milk. C. N. STARK, RUTH GORDON, J. C. MAUER, L. R. CURTIS, AND J. H. SCHUBERT, Cornell University, Ithaca, N. Y. Amer. Jour. Pub. Health, Vol. 24, No. 5, p. 470-472, 1934.

In an attempt to evaluate the therapeutic value of acidophilus milk, the fecal contents of 124 persons were examined over a period of 18 months. Of the 124 patients, 66 were constipated and 58 were considered normal in this respect. All of the persons examined were found to have on the average approximately 1000 lactobacilli per gram of their feces. During the time the patients consumed acidophilus milk, approximately 35 per cent of the fecal samples contained more than ten million lactobacilli per gram, and another 35 per cent contained in excess of one hundred million. These acidophilus types soon disappeared after the acidophilus milk was discontinued even though the patients continued to drink milk containing 3 per cent of added lactose.

Analyses of fecal samples before, during, and after acidophilus therapy showed (1) that there was little change in the number of non-sporulating gas producing colon types of bacteria in the fecal flora, (2) a definite tendency for the number of streptococci to decrease during the period of therapy, especially in the non-constipated group, (3) the number of spore forming anaerobes such as *Clostridium Welchii* tended to decrease during treatment, (4) there was a definite decrease in the amount of indol both in the feces of group fed acidophilus milk and the group fed sweet milk plus 3 per cent of lactose, (5) there was no appreciable change in the pH of the fecal contents during treatment, (6) the moisture content of the feces increased during the period of acidophilus therapy in both the constipated and non-constipated groups, but after discontinuing the treatment the moisture content of the feces from the constipated group soon reverted to the original low value, whereas that from the non-constipated group remained high, (7) of the 74 persons who completed the experiments, 29 of the 43 who were in the constipated group felt they had been definitely helped. A majority of the non-constipated group felt that they were in much better physical condition while they were drinking acidophilus milk.

Special milks. Report of the committee on milk and dairy products.
Year Book, Amer. Public Health Assn., 1933-1934, p. 63.

The outstanding progress in the past year in the methods of production of vitamin D milk, thus providing a sure and simple control of rickets and other conditions arising from a lack of vitamin D, is reviewed and discussed. Certain difficulties remain to be overcome, however, and these include a suitable standard by which the potency of milk may be measured and adequately marked on the bottle. As matters stand now the various methods of providing milk with additional vitamin D result in products of varying potency as measured by the Steenbock rat unit, irradiated milk supplying protection in 35 to 42 rat units, yeast milk in about double that number. The addition of cod liver oil concentrate requires an even greater number of rat units for an equal degree of protection. Further study is necessary to clear up these differences and arrive at a uniform measure of potency before legal standards can be set up. The question whether vitamin D milk is a food or a drug is discussed.

The place of homogenized milk in infant feeding is still very much in the experimental stage. It has been suggested that homogenized milk has a higher hydrogen-ion concentration. When the milk has not been previously heated higher than 120° F. this change in pH occurs almost immediately; a higher preheating causes the pH not to change for from 12 to 24 hours. Such milk spoils rapidly. The influence of homogenization on the vitamin content of milk should be further investigated, in the opinion of the committee.

A study of the effect of preserving methods on human milk. W. H. EDDY AND S. G. MORRIS. *Jour. of Ped.*, 4: 208, Feb., 1934.

Human milk collected for distribution when needed and preserved either by dehydration or by freezing has been examined for the effect of these processes on the nutritive value of the milk, in comparisons with fresh human and fresh cow's milk. The results indicate that freezing is an entirely satisfactory method of preservation, its effect on vitamins A, B and G being practically negligible. Some destruction of vitamin A was observed as a result of dehydration. Vitamins C and D were not present in either the fresh or preserved human milks in sufficient quantities to warrant omitting the usual supplementary orange juice and cod liver oil.

A study of breast milk fat. P. E. ROLLER. *Jour. Ped.*, 4: 238, Feb., 1934.

In a study of the water-insoluble acids in the fat of breast milk a comparison with those of cow's milk is given, showing that breast milk has a higher value for oleic, linoleic and palmitic acids, but that cow's milk is higher in other lower saturated acids.

Rapid methods for the quantitative determination of total protein and non-protein nitrogen in human and cow's milk. LESLIE DOUGLAS SCOTT, Charing Cross Hospital, Inst. of Pathology, London, England. *Biochem. Jour.* Vol. 28, No. 4, p. 1193, 1934.

This method is designed not to determine the total nitrogen content of milk but the true total protein content. The method used is as follows: To 10 milliliters of 0.45 per cent zinc sulphate in a 15 milliliter centrifuge tube add 1 milliliter of human or 0.50 milliliter of cow's milk. Mix well and add 2 milliliters of N/10 sodium hydroxide. After mixing centrifuge at 2000 r.p.m. for 5 minutes carefully pour off supernatant liquid and repeat process, this time using 10 milliliters of zinc sulfate solution and 1 milliliter of N/10 NaOH. With the use of as little water as possible transfer the precipitate to a digestion flask and add 5 milliliters of a digestion mixture of 50 milliliters 10 per cent copper sulphate, 300 milliliters of 85 per cent phosphoric and 100 milliliters of nitrogen free sulphuric acid. When digestion is complete transfer contents to a 250 milliliter flask and make up to volume. Nesslerize (Folin and Wu *J. Biol. Chem* 38: 81, 1919) 50 milliliters of this solution in a 100 milliliter graduated flask and dilute to volume. Compare the color produced to that of a Nesslerized unknown solution prepared from 3 milliliters of a standard ammonium sulphate solution (.494 g. per liter) and 1 milliliter of the digestion mixture in a 100 milliliter graduated flask.

$$\frac{\text{Standard}}{\text{Unknown}} \times 157 = \text{Mg N}/100 \text{ ml. human milk}$$

$$\text{This result} \times \frac{6.38}{1000} = \text{per cent of protein in human milk}$$

$$\text{Final result} \times 2 = \text{protein in cow's milk}$$

The results obtained by this method have been compared with those obtained with the tungstic acid precipitation method and the results have been found to agree very well.

Cost of production of market milk for Los Angeles. JOHN MARSHALL, JR., Div. of Markets, Calif. State Dept. of Agr., Sacramento, California. *Pacific Dairy Review*, Vol. 38, No. 10, p. 12, Oct., 1934.

The 74 producers from whom complete records were obtained, produced and sold for distribution as fluid milk, 3,308,836 pounds of butterfat during the year 1933, or approximately 16 per cent of the total amount of milk distributed in the Los Angeles sales area. Fifteen of the producers were tenants, and 59 owned part or all of the dairy farm operated. The average size of the farms was 61.80 acres, of which 19.51 acres were actually used by the dairy.

The average price received by the average producer in this area for the year 1933 was approximately 46.5 cents per pound butterfat. The average

cost of producing a pound of butterfat was 53 cents being made up as follows; rent 2.5, equipment 1.2, herd maintenance 3.1, feed 27.6, labor 13.1, operating 4.6, hauling 2.9 and from these expenses 1.9 cents was deducted for miscellaneous income.

Rate of growth and acid production of *Streptococcus lactis*. J. M. SHERMAN AND H. M. HODGE, Cornell Univ., Ithaca, N. Y. Jour. Dairy Science Vol. 17, No. 7, p. 497, July, 1934.

Evidence has been published to show that slow growth permits adaptation of an organism to its environment and hence the development of more resistant organisms. On this basis slow growing cultures should develop the more acid milk cultures. To test this hypothesis sterile milk was inoculated with *Streptococcus lactis* in varying amounts with the thought that the great dilutions would have only rapidly growing organisms which could not resist high acidity. In a general way it was found that very low inoculations reduced the final acidity developed in the culture. Again, if cultures are transferred at longer time intervals the effect of dilution in the inoculated milk should not exist as the slow growing organisms had time to develop. This was found to be true.

The effect of heat and chemical sterilization on the rubber parts of milking machines. J. L. HENDERSON, C. L. ROADHOUSE AND A. FOLGER, Univ. of California, Davis, California. Jour. Dairy Science Vol. 17, No. 7, p. 475, July, 1934.

Data have been secured on the life of rubber parts of milking machines and their sterility as a result of sterilization by hot water, chlorine solutions, and lye solutions.

It was found that heating rubber parts in water at 185° F. for 20 minutes was much more effective as a sterilizer than 170° for 20 minutes and did not appreciably shorten the life of the rubber. Both heat treatments reduced the lifetime of the rubber about one-third. A solution of 200 p.p.m. of chlorine and 0.3 or 0.5 per cent of sodium hydroxide gave slightly higher counts than heat sterilization. With chlorine solutions the life of the rubber was more dependent upon age than upon usage.

The differentiation of *Streptococcus lactis* from *Streptococcus fecalis*. J. M. SHERMAN AND PAULINE STARK, Cornell Univ., Ithaca, N. Y. Jour. Dairy Science Vol. 17, No. 8, p. 525, Aug., 1934.

There is some question concerning the identification of *Streptococcus lactis* and *Streptococcus fecalis* as the two species are so nearly identical.

The authors have used four tests by which these two groups may be readily differentiated. (1) None of the *lactis* cultures grow above 45° C. while *fecalis* has its optimum temperature at 48-52° C. (2) All cultures of *lactis* in skimmilk were killed at 65° C. for 30 minutes while all cultures

of fecalis survive. (3) When seeded in lactose nutrient agar fecalis grows rapidly at pH 9.6 whereas lactis is entirely inhibited. (4) Cultures of *Streptococcus lactis* were all inhibited by 6 per cent salt while fecalis grew well in 6.5 per cent salt solutions.

A new method for converting average whole milk into soft curd milk.

ERIK LUNDSTEDT, Pfister Chem. Company, Ridgefield, N. J. Milk Plant Monthly, Vol. 23, No 7, 1934.

Human milk is easier to digest than is cow's milk. The reason is that mother's milk forms fine curds; whereas cow's milk forms large hard curds. When cow's milk is diluted with water it is easier to digest than in its normal state, but basically the nature of the curd remains unaltered. Dilution tends to retard digestion.

The curd tension is decreased about 30 per cent when milk is boiled. Adding 3 per cent of lemon juice or 8 per cent of orange juice renders the average milk more digestible. It also increases the vitamin C potency of the milk.

The Hill curd method is described. Milk ranges from 5 to 200 Hill grams in curd tension. The average milk in the U. S. A. ranges from 50 to 70. A range of 5 to 30 is standard for soft curd milk.

Homogenizing milk at 40 to 45° C. (104 to 113° F.) at 300 or more pounds of pressure will decrease the firmness of the curd. About 25 per cent of the casein is adsorbed on the fat from the serum as a result of homogenization.

Curd can be softened by passing milk through Zeolites removing 20 per cent of the calcium. This necessitates an increased consumption demand since 6 units in place of 5 of milk are required to give equal calcium values.

Influence of mastitis on the curd tension of milk. H. C. HANSON, D. R.

THEOPHILUS, F. W. ATKESON, AND E. M. GILDOW, Idaho Agr. Exp. Station, Moscow, Idaho. Jour. Dairy Science, Vol. 17, No 3, p. 257, March, 1934.

Composite samples of milk from 26 Holstein and 20 Jersey cows were examined for bacterial content, special types of bacteria, leucocytes and for hardness of curd. Some samples from individual quarters were also studied. The udders of the cows were examined physically for mastitis.

Consideration of the data showed that the usual streptococci mastitis lowered the curd tension of milk while staphylococci infections had no effect. Classification of orders on the basis of fibrous tissue gave no relationship to the curd tension of milk.

The authors believe that undue emphasis has been given to the possibility of mastitis producing soft curd milk. This is particularly very improbable in dairies which have veterinary supervision.

Outbreaks of milk poisoning due to a toxin-producing staphylococcus found in the udders of two cows. JAMES A. CRABTREE AND WILLIAM LITTERER, Tenn. State Dept. of Health, Nashville, Tennessee. *Amer. Jour. Pub. Health*, Vol. 24, No. 11, p. 1116-1122, Nov., 1934.

A series of outbreaks of gastro-enteritis among the students and faculty in a boarding school showed a definite periodicity of 7- to 10-day intervals. There were 242 cases among the 97 persons, 12.4 per cent of them having as many as 5 reoccurrences. Chemical and bacteriological analyses of all foods gave negative results except in the case of milk. Hemolytic staphylococci were isolated from the milk served as well as from the throats and the vomitus of those suffering from the malady. Of the 242 cases, all but one occurred in persons who had drank milk during the meal immediately preceding the onset. The filtrates prepared from the isolated cultures of staphylococci contained a large amount of toxic substance. Human volunteers who consumed milk containing only 3 cc. of this filtrate became violently ill showing the characteristic symptoms from 30 to 90 minutes following ingestion.

Bacteriological examination of the milk from individual cows in the herd revealed the presence of the same hemolytic types of organisms in the udders of two of the animals. Periodic examination of the milk from these two animals revealed the interesting point that the numbers of staphylococci gradually decreased daily until none was present then suddenly large numbers appeared the following day. This was again followed by gradual diminution to zero when another showering of staphylococci occurred. The periodicity of these "showers" of staphylococci agreed in length with the periodicity observed in the epidemics among the students.

The importance of adequate refrigeration is emphasized by the fact that no cases of the disease occurred among the families occupying two residences on the campus where milk from the same herd was consumed. The milk delivered to these two homes was in small containers and efficiently refrigerated. The milk was delivered to the dormitories in 10-gallon cans and placed in a cooler operated at a temperature several degrees higher than prevailing in the electric refrigerators in the two homes. It is believed the more efficient cooling of the milk in these two homes retarded the development of the staphylococci sufficiently to prevent the disease among the consumers.

Bacteriological changes in acidophilus milk at room and ice-box temperatures. LENORE M. KOPELOFF, JOHN L. ETCHells AND NICHOLAS KOPELOFF, Psychiatric Institute and Hospital, New York. *Jour. Bact.* Vol. 28, No. 5, p. 489-500, Nov., 1934.

An important point in the sale and use of acidophilus milk is to retard the death of the cells after the inoculated milk has ripened. Early work

reported by these authors revealed that the acidophilus organisms diminished in numbers more rapidly at ice-box temperatures than when stored at room temperature. Since this is rather contrary to the usual practice of refrigeration in the preservation of food, the statement has been challenged and in some instances data submitted to show that the reverse is true. Acidophilus organisms may be divided into two physiological groups, described as "rough" (R) and "smooth" (S) according to the nature of the colony produced when the strain is grown on artificial media. The R type is known to be of therapeutic value, whereas there is considerable evidence to suggest doubt as to the therapeutic value of S type.

The authors subjected pure cultures of R and of S types to various storage temperature conditions and found that in general the R types (those of therapeutic value) died much more rapidly at ice-box temperature, whereas the S types tended to die less rapidly at the lower temperature.

Infectious bovine mastitis. 2. The streptococci of chronic bovine mastitis. WAYNE N. PLASTRIDGE, E. O. ANDERSON, G. D. BRIGHAM AND E. H. SPAULDING, Dept. of Animal Dis. and Dairy Husb., Conn. State College, Storrs, Conn. Conn. Agr. Exp. Sta. Bull. 195, March, 1934.

This study is based upon the examination of 208 strains of streptococci which were divided into 9 groups on the basis of methylene blue reduction, litmus milk reaction, ability to split aesculin, the sodium-hippurate test, and fermentation reactions. It was concluded that infectious chronic bovine mastitis is most commonly caused by a fairly well-defined group of streptococci, which should be regarded as a distinct species bearing the name *S. mastitidis*.

Of the 208 strains 87 per cent were from animals (with one exception) that had shown definite evidence of mastitis. Eleven per cent of the strains comprised a group differing from the previous one in that they fermented mannitol, reduced methylene blue milk, usually, and had a relatively low degree of virulence, causing a very mild form of mastitis. Animals infected with organisms of the first group rarely recovered completely, while those infected with organisms of the second group commonly recovered within a period from several months to a year.

In formulating plans of controlling mastitis due to streptococci a distinction should be made between animals harboring the two types of organisms described.

Chronic mastitis. G. J. HUCKER AND P. ARNE HANSEN, New York State Agr. Exp. Station, Geneva, N. Y. N. Y. Agr. Exp. Sta. Cir. 147, Aug., 1934.

This circular explains the two common types of mastitis (acute and chronic) and describes methods of determining the presence of the disease.

A summary of the directions given for bringing mastitis under partial control follows:

1. Test each quarter in the herd at regular intervals by either the strip cup or brom thymol blue test.
2. Segregate all cows reacting to either of these tests, as well as all cows giving milk that shows evidence of being infected.
3. All replacements should be tested (brom thymol blue) before being added to the herd. If replacement is dry, the advice of a competent veterinarian should be secured.
4. See that all cows are properly stripped out after milking.
5. Watch carefully all cows with injured quarters.
6. Sanitary precautions should be taken in the general management of the herd.
7. If trouble is still experienced after using the above methods, get in touch with your milk inspection laboratory or a veterinarian for a more intensive study of the herd.

The distribution of *Brucella abortus* in the infected udder. REDVERS THOMPSON. *Canad. Pub. Health J.*, 25: 229, May, 1934.

A study of the milk from each quarter of the udder of fifteen cows showed that *Brucella* organisms were present in the right hind quarter of all but two, indicating a possible higher susceptibility here than in other quarters. The organism was continuously excreted with the milk from infected quarters during the lactation period unless clinical symptoms of mastitis appeared, when the *Brucella abortus* organisms disappeared.

Undulant fever due to *Brucella* of the porcine type: Report of a milk-borne epidemic. C. P. BEATTIE AND RAYMOND M. RICE, Council Bluffs, Iowa. *Jour. Amer. Med. Assoc.* Vol. 102, No. 20, p. 1670-1674, 1934.

During the months of February, March and April 1933, 30 cases of undulant fever appeared in epidemic form in the city of Council Bluffs, Iowa. Epidemiological and bacteriological investigations revealed that 27 of these 30 patients obtained their milk from the same dairy. The dairy herd involved supplied 80 homes; in 18 of these, cases of undulant fever developed. *Brucella suis* was obtained in blood culture from 6 of 14 patients and from the milk of one of the 20 cows in the herd. The epidemic ceased 13 days after the stoppage of the sale of the milk from this dairy. The authors conclude that *Brucella suis* has greater virulence than *Brucella abortus*.

Bovine tuberculosis. EDITORIAL. *Jour. Amer. Med. Assoc.*, Vol. 102, No. 1, p. 48-49, 1934.

The death rate from respiratory tuberculosis in the United States has decreased every year since 1918 from 128.6 to 56.6 per 100,000 population in 1933. The death rate from non-respiratory tuberculosis decreased each year from 22.5 in 1917 to 6.7 per 100,000 in 1933. It is significant to note that these death rate values either increased or failed to decrease during 18 year period 1900-1918 and that the decline in the curves is coincident with the institution of an intensive program of elimination of dairy animals which react to the tuberculin test. Although this is obviously not the only factor involved, it is of interest to note that only 1.9 per cent of the 13,500,000 animals tested in 1932 were reactors, whereas 4.9 per cent were found positive in 1918. During the period from 1918 to 1933 there have been 115,170,388 animals tested and 2,693,570 reactors found.

Laboratory methods for the detection of milk from cows infected with mastitis. W. V. HALVERSEN, V. A. CHERRINGTON AND H. C. HANSEN, Univ. of Idaho, Moscow, Idaho. Jour. Dairy Science, Vol. 17, No. 4, p. 281, April, 1934.

The results of laboratory tests on milk from individual quarters of normal cows and cows suffering with acute and subclinical mastitis are reported. The tests made included the bacterial count on plain and blood agar, the type of infection, leucocytes per cubic centimeter, catalase, pH, chlorides, and grams of curd tension for the Hill's curd test. The various clinical tests used to detect pus were also applied to milk from udders known to be infected. More tests were also made to correlate the wide variation in curd tension which exists between quarters of the same udder with the various clinical observations made.

In general, the conclusions of this paper are as follows: (1) Acute mastitis produces such marked changes in the milk that it is easily recognized as being abnormal. The bacterial content, the leucocyte content, catalase content, pH value, chloride content and curd tension are all markedly affected. (2) Subclinical mastitis is very common; the milk generally appears normal and the condition generally goes unrecognized. A leucocyte content greater than 100,000 per cubic centimeter and a catalase content which produces more than 2.5 cc. of gas in 6 hours, according to the method described by Orla-Jensen, gave what appeared to be the most reliable indices of udder infection. (3) The addition of blood serum to milk reduces the curd tension much greater than the same degree of dilution by water. (4) Chemical tests commonly employed for the detection of pus in urine yielded negative when applied to milk from udders harboring subclinical mastitis. (5) Fifty-four samples of retail milk were tested; thirty-three samples contained excessive catalase and thirty-four samples contained more than 100,000 leucocytes per cubic centimeter. (6) These data emphasize the desirability of determining the presence of udder infection simultaneously with the curd tension.

Undulant Fever. J. L. MILLER. *Ann. Int. Med.* 8: 570, Nov., 1934.

A review of the laboratory and clinical work done on undulant fever shows that so far "the best preventive measure is pasteurization of milk." Efforts to immunize cattle or eradicate contagious abortion entirely are slow processes, and so far have not been successful. Infection in man may result from the use of raw dairy products from infected herds or from contact with infected animals. No successful form of treatment has been discovered, beyond rest, fresh air, nourishing food and treatment of local conditions which may arise. It is emphasized that diagnosis should not be based exclusively on any one of the numerous tests which are now in use, but two or more should be employed, as none give positive reactions every time.

Determination of carotene as a means of estimating the vitamin A value of forage. H. R. GUILBERT. *Coll. of Agr., Univ. of California, Davis, California.*

Karrer and Schlientz (*Helv. Chim. Acta.* 17: 7, 1934) have shown that carotene preparation from grasses, spinach, or nettles, is almost pure B carotene. Furthermore, no pre-formed vitamin A has been found in any plant source. B carotene is equivalent in biological value to vitamin A. Hence, the colorimetric test for B carotene which the author presents should reflect fairly accurately the vitamin A content of forage.

In general, the color values upon the carotene and xanthophyll as well as the unsaponifiable fractions varied with variations in the carotene content of the forage. Though the variations were not in all cases proportional to that of the carotene content the trend was sufficiently close to show that no serious error would be involved in comparing the biological value of different feeds on the basis of carotene, though xanthophyll or other substances contributed to the vitamin A activity. The results upon the samples used show that a product field cured under favorable conditions may closely approach the dehydrated meal in its vitamin A content.

Factors influencing the utilization of calcium and phosphorus of cow's milk. J. H. HESS, H. G. PONCHER AND HELEN WOODWARD, College of Medicine, Univ. of Illinois, Chicago, Illinois. *Amer. Jour. Dis. of Children*, Vol. 48, No. 5, p. 1058-1071, Nov., 1934.

One of the major problems in the use of cow's milk for infant feeding has been the suitable adjustment of the physical character of the curd. The three main factors governing the character of the curd formed in the child's stomach are the casein, rennin, and the calcium ions. Regulation of curd character involves a readjustment of one or a combination of these three factors. Recent clinical experiences with the natural "soft-curd" milk from selected cows indicate that its variability makes it less desirable than milk carefully adjusted under controlled conditions.

A recent method of adjusting the physical character of the curd has been to increase the amount of soluble calcium of milk by acidification with 0.3 per cent citric acid, then removing this calcium by ultrafiltration through a zeolite (sodium-aluminum silicate). The resulting product does not form a curd with rennet and it was found that about 20 per cent of the calcium had been removed. The work reported in this paper was conducted primarily to determine if milk produced by this base-exchange method carried enough calcium to keep the child on a positive calcium and phosphorus balance. The results showed that 100 cc of such milk per kilogram of body weight will keep a normal growing infant in a positive calcium and phosphorus balance. Although there is a reduction in the amount of calcium and phosphorus in milk treated by base exchange, the results of metabolism study indicate that the utilization of these elements is more efficient. The possible mechanism by which more efficient utilization takes place is attributed to three factors; (a) the size of the curd, (b) the state of the calcium, and (c) the reaction of the ash.

Special milk in the solution of the iodine deficiency problem. WM. D. WESTON, Columbia, South Carolina. *Archives of Pediatrics*, Vol. 51, No. 11, p. 683-690, Nov., 1934.

Previous work by the author has shown that in certain sections of the country where the amount of iodine in the soil is low, there is a definite parallelism between the iodine content of the vegetables grown and the milk produced. In these sections there is a high incidence of goiter, especially among children. There is ample evidence to indicate that the time most suitable to correct the iodine deficiency and thereby prevent goiter is during the early stages of childhood while the food consists largely of milk. Since it is possible to increase the iodine content of milk by feeding this element in suitable form to the cow, a study was made to determine the possibility of producing milk higher in iodine content in these so-called goiterous-regions. Carefully regulated feeding practices were instituted in those regions. Samples of the milk were analyzed periodically over a 10 month period as a check against seasonal variation. The results showed considerable variation in the iodine content of milk produced in various sections and in various seasons of the year. The highest iodine content of milk analyzed from Abbeville, S. C., was 1170 parts per million, and from Greenville, S. C., 1870 parts per million. Samples from Bainbridge, N. Y., and from Columbus, Wisconsin, showed maximum iodine values of 392 and 395 parts per million respectively.

Cooperative experiments were conducted with pediatricians in various parts of the country in which children of all ages were fed at predetermined levels of iodine intake. The data are not presented, but the conclusions from these feeding trials were (1) that children receiving milk high in iodine

content grew at a more rapid rate and more consistently than those on a low level of iodine intake. (2) by use of milk high in iodine it was possible to maintain a high hemoglobin content in premature twins and triplets. (3) weight increased upon a more nearly normal scale in the children receiving milk high in iodine. (4) habitual vomiting was successfully corrected by the use of this milk in all but one case. (5) milk high in iodine gave definite improvement of cases of debility and slow development. (6) a few cases of beginning goiter were corrected by the use of this milk, and (7) in the few cases studied, positive balances of calcium-phosphorus, and magnesium were maintained.

A milk and banana diet for the treatment of obesity. GEORGE A. HARROP, Baltimore, Maryland. *Jour. Amer. Med. Assoc.*, Vol. 102, No. 24, p. 2003-2005, 1934.

The strict diet consists of 6 large well-ripened bananas and 1000 cc (about 1 quart) of skimmed milk to be eaten as three or more meals per day spaced according to the personal food habits of the patient. The diet is followed for 10 to 14 days and usually produces weight losses of from 4 to 9 pounds in persons who are active and carry on their usual living routine. Reduction of the diet to 4 bananas daily is well tolerated by some individuals and produces more pronounced reduction in weight.

After 10-14 days alterations may be made by substituting one or 2 eggs, some green vegetables, a little butter, a small bit of lean meat for one or two bananas. The diet as outlined is advocated because it is simple, cheap, readily available, palatable and effective.

Nutrition and Child-bearing. EDWARD MELLANBY, Univ. of Sheffield, Sheffield, England. *Certified Milk* Vol. 9, No. 95, p. 6, March, 1934.

Malnutrition during pregnancy is not necessarily due to the lack of sufficient energy-bearing food, but more commonly to the lack of certain factors essential to normal metabolism of the food ingested. Although there are, no doubt, many more factors involved in nutrition than the present status of knowledge reveals, it is well established that calcium, phosphorous, iodine, iron, and vitamins A and D are essential to normal metabolism. Evidence is rapidly accumulating to suggest that the toxemias of pregnancy such as albuminuria, spasmodic nausea, etc., may be the result of malnutrition.

As a general guide, the daily diet during pregnancy should include one quart of milk, one or two substantial servings of green vegetables, one or two egg-yolks, fresh fruit, 2 teaspoonfuls of cod liver oil, sea food twice each week and calf's liver once each week.

Pasteurized versus raw milk. Foreign Correspondent of London. *Jour. Amer. Med. Assoc.*, Vol. 102, No. 22, p. 1860, June 2, 1934.

The report of a committee from the Royal College of Physicians which was unanimously adopted included the following items. (1) A daily ration of milk is important for the growth and health of children. (2) The risk of tuberculosis and other diseases following the consumption of raw milk is considerable. (3) Such risk can be obviated by the use of milk submitted to low temperature pasteurization. (4) Such pasteurization does not materially interfere with the nutritive value of milk. The college while realizing that milk should be produced from cows free from infection and under conditions of cleanliness recommends, (a) that local health authorities should be given power to require that milk sold within their areas should be pasteurized under official control, (b) that steps should be taken to permit the pasteurization and sale, as such, of milk from tuberculin-tested herds, and (c) that in areas where adequate pasteurization is now impracticable milk should be boiled before use.

The Milk Marketing Board (appointed by the government to control the milk industry) has produced a pure milk scheme to become effective in October, 1934. It is proposed to prescribe a standard of purity for milk, and producers who conform to it will receive a bonus on every gallon of milk. Funds for this bonus will be provided by a small levy on all producers of milk. The new grade will be termed "accredited milk." The farm, the cow, and the milk will be subject to expert examination by local health authorities. The object is not to produce a high-quality superior grade of milk, but to raise the general standard of milk.

Prevention of rickets by milk fortified with vitamin D from cod liver oil.

WILLIAM R. WILSON, Yale University, New Haven, Conn. Jour. Amer. Med. Assoc., Vol. 102, No. 22, p. 1824-1831, June 2, 1934.

Thirty-three infants, most of whom were under 8 weeks of age at the beginning of the experiment, two-thirds of whom were either negroes or Italians, were fed special milk fortified with 150 Steenbock units of vitamin D from cod liver oil for a period of from three to six weeks. X-ray pictures revealed that 14 of the 33 infants remained normal, 17 developed slight rickets and two a moderate degree of rickets. When the number of units of vitamin D taken daily per 100 grams of weekly gain in weight was correlated with the degree of rickets, it was found that the average number of units taken by the nonrachitic infants was somewhat greater than the average number taken by those who showed slight rickets, and considerably greater than the number taken daily by the two infants who developed moderate rickets.

Since the requisite amount of vitamin D depends upon the rate of growth, and since some infants grow more than others, it is clear that rapidly growing infants may not receive adequate vitamin D in amounts of milk less than one quart per day. The data presented show that certain fast growing in-

phants who used less milk than others per unit of growth were not protected by milk containing 150 Steenbock units per quart. Minimum vitamin D standards should necessarily be determined by further work.

The prevention of dental caries. *Lancet*, Feb. 3, 1934, page 245. Diet and the teeth, *Lancet*, Feb. 3, 1934, page 257. Diet in relation to dental structure and disease. *Brit. Med J.*, Feb. 10, 1934, page 252. Diet and the teeth. Editorial. *Brit. Med. J.*, Feb. 10, 1934, page 246.

These four papers summarize and discuss the third and last report by Mrs. Mellanby on her outstanding investigation of the development and preservation of teeth.

Beginning some seventeen years ago with a study of the dental structure of dogs and other animals, the third and most recent report of a clinical study on the teeth of 400 children confirms previous conclusions reached by the author that diet is a more important factor in the formation of sound teeth than is oral hygiene. A close relationship between the structure of the tooth and the incidence of dental caries was observed.

Examination shows that the large majority of the population of England has faulty tooth construction and any effort to correct this condition must result in a rather complete change in dietary habits. Milk, eggs, cheese, animal and fish fats, and vegetables should be used liberally and very little, if any cereals. Cod liver oil or some other source of vitamins A and D should be given to all children.

Nutrition in normal and abnormal pregnancy. New developments in relation thereto. J. C. HIRST. *Pa. Med. J.*, 37: 377, Feb., 1934.

In a short paper discussing nutritional requirements in pregnancy the author recommends the inclusion of a quart of milk daily in a diet made up of cereals, fruits, vegetables and meat. Very little carbohydrate is given. The maintenance of an adequate calcium level is important and the supplementary administration of vitamin D is recommended.

Specially produced milk in the solution of the goiter problem. WILLIAM WESTON. *South Med. Jour.*, XXVII: 249, March, 1934.

Adequate control of the goiter problems in children will come, according to this author, only through foods in which the organic iodine content is high. Of all foods, milk is the most universal and may carry a higher iodine content than others. Clinical studies in several sections of the country known for their high goiter incidence showed that when children were given a dried milk rich in natural iodine, symptoms of deficiency were almost entirely absent. Calcium and phosphorus values are favorably influenced by a high iodine intake, as are also growth and development. Irradiation has been found to increase the utilization of iodine, iron, calcium and phos-

phorus in milk and is, therefore, of value in the solution of the goiter problem. The product used in this study was Dryco.

Relation of diet to dental caries. H. F. HAWKINS. Jour. Am. Dent. Assn. April, 1934, p. 630.

The development of dental caries as a result of acids formed by fermenting starches may be prevented by maintaining the proper acid-base balance and calcium-phosphorus ratio. Adequate intake of certain elements as well as proper assimilation must be assured in order to keep a sufficient alkaline reaction in the body. Milk is important in increasing alkalinity and also provides sufficient calcium to fulfill the requirements. Furthermore, it increases assimilation and elimination of phosphorus. Fruits, vegetables, meat, fish and eggs also have important places in the maintenance of an alkaline reaction.

Vitamin D milk and the teeth. JAMES A. TOBEY. Dental Survey, March, 1934, p. 57.

The importance of calcium, phosphorus, and vitamin D in the formation of healthy teeth makes the increasing availability of vitamin D milk of outstanding importance to dentists as well as to physicians. The administration of a quart of vitamin D milk daily to all pregnant and nursing mothers, and to infants and children will not only prevent rickets but will insure better teeth in the children and will also help preserve the teeth of mothers.

Methods by which the vitamin D content of milk may be increased are outlined, and the advantages of the product over cod liver oil, viosterol or other concentrates are pointed out. Experiments have shown that the potency of vitamin D milks per rat unit is much more efficacious than that of the concentrates. The danger from overdosage of vitamin D milk is so slight as to present no problem.

Dental caries III. Rickets in relation to caries in the deciduous and in the permanent teeth. A. F. HESS, H. ABRAMSON AND J. M. LEWIS. Amer. J. Dis. Child., 47: 477, March, 1934.

Observations on a group of 1167 children between the ages of 6 and 9 years, brought out the fact that the occurrence of rickets in infancy and of dental caries in the permanent teeth were not correlated. These children had been closely observed from infancy. Some had been protected from rickets by means of cod liver oil or other anti-rachitic, others had not. The deciduous teeth in the rachitic group showed a definitely higher incidence of caries than did the non-rachitic. Children admitted to the institution before one year of age showed fewer caries than did those admitted between three and four years. An interesting observation was made on a group of Negro children in New York City, among whom the incidence of rickets is much

higher than in the white races. These Negro children had permanent teeth much freer from caries than did white children.

The authors conclude that dental caries is not due to rickets but to nutritional disturbance in childhood and early adult life, as calcification of the permanent teeth does not begin until after the age when rickets commonly occurs.

Vitamin D, either as cod liver oil, viosterol or vitamin D milk, is essential for proper calcification of teeth and bones. It is suggested that "Calcifying" is a better descriptive term than "antirachitic" for this vitamin, the value of which goes far beyond the prevention and cure of rickets alone.

Vitamin D certified milk. W. E. BROWN. *Jour. of Med.*, XV: 88, April, 1934.

Bio-assays on certified milk produced on farms under its jurisdiction by the Medical Milk Commission of the Academy of Medicine of Cincinnati showed the milks to contain at least 160 Steenbock rat units per quart, which is better than that of 3 teaspoonsful of cod liver oil or 10 drops of viosterol daily. The commission states that physicians are safe in prescribing this milk for antirachitic purposes.

Relation of ingestion of milk to calcium metabolism in children. A. L. DANIELS, M. K. HUTTON, E. KNOTT, G. EVERSON AND O. WRIGHT, Iowa State College, Ames, Iowa. *Am. J. Dis. Child.*, 47: 499, March, 1934.

A study of calcium, phosphorus and nitrogen retention in a group of children, 3 to 5 years of age, whose diets differed principally in the amount of calcium furnished by either 1 pint or 1 quart of milk daily, suggests that the physiologic differences in individuals may account for the fact that some do better on less milk than others do on more.

Children receiving plenty of fresh vegetables, eggs, fruits and meat as well as milk, and supplemented with viosterol or cod liver oil, may not need as much milk for optimum growth and development as do other children whose dietaries are not so well balanced or do not furnish sufficient protein, phosphorus and vitamins. It is further suggested that children whose dietaries are consistently on a high nutritional level do not show as great retention as do those whose bodies have been depleted through faulty diets over a long period of time.

Influence of fluorine ingestion upon the nutritional qualities of milk. P. H. PHILLIPS, E. B. HART AND G. BOHSTEDT, College of Agriculture, Madison, Wis. *Jour. Biol. Chem.*, 105: 123, April, 1934.

Although it has been shown that the ingestion of small amounts of fluorine is harmful to the teeth, the authors have been unable to demonstrate this fact in a series of experiments in which rats were given exclusive milk

diets from cows whose diets were supplemented with fluorine. No noticeable difference in residual fluorine of the body ash was observed in rats receiving milk from cows to whose diets fluorine had been added and rats receiving milk from cows whose diets did not contain added fluorine. It was further observed that the fluorine content of milk was difficult to influence by dietary methods.

A study of the relative antirachitic value of cod liver oil, viosterol and irradiated milk. T. G. H. DRAKE, F. F. TISDALL AND A. BROWN.
Canad. Med. Assn. Jour., 31: 368, Oct., 1934.

A group of 529 infants in the city of Toronto were given antirachitics in the form of viosterol, cod liver oil, or irradiated vitamin D milk for a period covering five winter months. Presence of rickets was determined by means of x-ray. The infants were divided into two age groups, as younger, more rapidly growing babies are more susceptible to rickets, the younger group included all infants under four months of age, when the study was begun; the other group, infants from four to eight months. No moderate or severe rickets developed in any infants receiving from 1.5 to 12 drops of 250D viosterol, or irradiated milk containing 35 Steenbock units of vitamin D per 20 ounces, while only three out of the 137 receiving cod liver oil developed rickets. Difficulty in the administration of a suitable dose of cod liver oil may account for these three cases. One teaspoon of cod liver oil was as efficacious as three in preventing rickets. In conclusion the authors state that "in irradiated vitamin D milk we have a valuable addition to our present antirachitic armamentarium."

A new concentrate for producing vitamin D milk with added vitamin A potency. FRANK J. HOLT, Health Products Corp., Chicago, Illinois.
Milk Plant Monthly Vol. 23, No. 9, 1934.

Vitamin D milk is the most discussed food product on the market at present.

The Health Products Corporation of Newark, New Jersey, have developed a method of preparing a vitamin A and D concentrate by removing them in the non-saponifiable fraction which is about 1 per cent of the total fats. One pound of the concentrate will fortify (150 Steenbock units) 10,080 quarts of milk. Some secret steps in the manufacture are not presented.

The concentrate is emulsified into a small volume of milk which is added to the large volume of milk.

Vitamin D milk by the addition of refined cod liver oil concentrate.
BION R. EAST, National Oil Prod. Company, Harrison, N. J. Milk Plant Monthly Vol. 23, No. 4, 1934.

The concentrate is prepared according to methods developed by Theodore

F. Zucker and patented for Columbia University. It has 1000 times the vitamin D potency of the original oil. It does not alter milk flavor.

The concentrate contains 900,000 Steenbock units per pound. One pound of the concentrate per 6000 quarts of milk is required to obtain the 150 Steenbock units desired in each quart of the milk. The concentrate is mixed with a small amount of milk. This is added to the main bulk of milk just before pasteurization.

Clinical tests have revealed that 50 Steenbock units of vitamin D per quart of milk are required to prevent rickets. Vitamin D milk prepared with the Zucker technique has been approved by the American Medical Association.

The concentrate is prepared by treating cod liver oil with 95 per cent ethyl alcohol, which dissolves the vitamin D and some of the fatty acids. From the alcoholic solution the fatty acids are saponified and precipitated as calcium soaps. This mass is treated with acetone. The acetone solution containing the vitamin D is separated, concentrated and treated with ether. The ether is finally distilled off leaving a waxy, tasteless and odorless product containing a high concentration of vitamin D.

A comparison of the nutritional and growth values of certain infant foods. C. T. WILLIAMS AND A. O. KASLER. *Jour. Ped.*, 4: 454, April, 1934.

Sixty infants divided into three groups of 20, each group given a different formula, were compared with each other and with a control group of 20 breast fed infants as to nutritional condition, growth, incidence of respiratory and other infections, and presence of rickets. The three formulas used were (1) certified milk, milk sugar, lime water and water; (2) evaporated milk, milk sugar and water; and (3) Mariott and Schoenthal's lactic acid evaporated milk and corn syrup formula. The study was undertaken to determine the comparative advantages of fresh and canned milks for infant feeding.

The infants were observed for 6 months and during that time received cod liver oil and orange juice routinely. A study of the nutrition and growth of these 60 infants indicates that fresh and evaporated milks are equally successful in infant feeding, but that the superior digestibility of evaporated milk due to the heat treatment caused fewer digestive upsets in the groups receiving this form of milk. For infants under 3 months it was found necessary to dilute one-third the Mariott lactic acid formula to prevent digestive disturbances.

A vitamin B deficient ration. R. C. BENDER, G. E. FLANIGAN AND G. C. SUPPLEE, The Dry Milk Company, Bainbridge, N. Y. *Jour. Nutrition* Vol. 8, p. 357, 1934.

Autoclaved yeast or yeast concentrates are most commonly employed as a source of vitamin G in vitamin B deficient rations. Milk is relatively high in vitamin G and low in vitamin B. The authors find that dry whey autoclaved for 2 hours at 120° (248° F.) contains no vitamin B, as indicated by the growth of white rats, and that 15 per cent of this dry whey in feeds supplies an amount of vitamin G sufficient for growth. In their work they obtained more consistent and satisfactory results with this product and a source of vitamin G free from B than from autoclaved yeast.

The vitamin B supplementation of milk. G. C. SUPPES, R. C. BENTON AND G. E. FLANIGAN, The Dry Milk Company, Danbridge, N. Y. Jour. Nutrition Vol. 8, p. 365, 1934.

That vitamin B affects growth and efficiency of food utilization appears to be an observed fact. These authors found that there is a definite relationship between the rate of growth of white rats and the amount of vitamin B supplied in the feed.

Dry milk containing from polished rice shown by the milk alone increases the efficiency unit of food intake. It is polished by simple extrusion, vacuum, spray dried and distributed in potency.

was found that the rate of growth of white rats was directly proportional to the amount of vitamin B supplied in the feed. The authors found that the rate of growth of white rats was directly proportional to the amount of vitamin B supplied in the feed.

The fat-soluble vitamins

that are in milk

are the vitamins A, D, E, and K.

The amount of these vitamins in milk is determined by the amount of fat in the milk.

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characteristics of the flowing film required for optimum
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Edge, N. Y., and M. J. DORCAS, The National Carbon
Ohio, Jour. Dairy Science Vol. 17, No. 6, p. 527,

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Autoclaved yeast or yeast concentrates are most commonly employed as a source of vitamin G in vitamin B deficient rations. Milk is relatively high in vitamin G and low in vitamin B. The authors find that dry whey autoclaved for 2 hours at 120°. (248° F.) contains no vitamin B, as indicated by the growth of white rats, and that 15 per cent of this dry whey in feeds supplies an amount of vitamin G sufficient for growth. In their work they obtained more consistent and satisfactory results with this product and a source of vitamin G free from B than from autoclaved yeast.

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That vitamin B affects growth and efficiency of food utilization seems to be an observed fact. These authors found that there is a direct linear relationship between the rate of growth of white rats and the amount of vitamin B supplied in the ration.

Dry milk containing a concentrated water extract of vitamin B obtained from polished rice showed greater growth promoting properties than was shown by the milk alone. Vitamin B with or without milk supplementation increases the efficiency of food utilization as judged by growth response per unit of food intake. Potent vitamin B extracts may be prepared from rice polish by simple extraction procedures, and these may be condensed in vacuum, spray dried or dried by the Just process without significant diminution in potency.

The fat-soluble vitamins and dental caries in children. C. D. MARSHALL DAY AND H. J. SEDGWICK, Univ. of Rochester, Rochester, N. Y. Jour. Nutrition Vol. 8, p. 309, 1934.

The diets of 147 of 318 children of approximately 13 years of age were supplemented with 6000 U.S.P. units of vitamin A and 1470 Steenbock units of vitamin D in the form of viosterol. The remainder of the group (171) were kept under observation as checks. No attempt was made to in any way interfere with the food intake. From the results the conclusion is drawn that without altering the diet the administration of vitamins A and D to children of this age and within the period of investigation (15 mos.) has no appreciable effect upon the rate of progress of the caries process in teeth already erupted or which erupt during the experimental stage.

Vitamin Studies. XIX. The assimilation of carotene and vitamin A in the presence of mineral oil. R. ADAMS DUTCHER, PHILIP L. HARRIS, EWA R. HARTZLER AND N. B. GUERRANT, Penn. State College, State College, Pa. Jour. Nutrition 8, p. 269, 1934.

Former work by Dutcher, Ely and Honeywell have shown that rats are unable to utilize vitamin A in butterfat when the latter is dissolved in min-

eral oil. Later work showed that this generalization was not applicable to vitamin A in cod liver oil which was utilized more efficiently than that from butterfat under similar conditions.

In the present work these conclusions were confirmed, especially at the lower levels of vitamin A feeding. The harmful effect of mineral oil can be explained on the basis of carotene excretion from the body in the unabsorbed mineral oil. This hypothesis is supported by the fact that the yellow pigment excretion is roughly proportional to the carotene ingested. This is not true when carotene is fed in the absence of mineral oil.

Irradiated milk: Characteristics of the flowing film required for optimum efficiency of antirachitic activation. G. C. SUPPLE, The Dry Milk Company, Bainbridge, N. Y., and M. J. DORCAS, The National Carbon Co., Inc., Cleveland, Ohio. Jour. Dairy Science Vol. 17, No. 8, p. 527, Aug., 1934.

The flow of milk films over smooth vertical surfaces by gravity can be differentiated as films with dominant smooth flow characteristics, or dominant turbulent flow characteristics.

Milk may be activated to a 2+ degree of calcification, as determined by standard assay procedures under a wide range of properly coordinated conditions involving film capacity, film thickness and distance of film travel, within a momentary period of exposure. There are certain optimum conditions wherein the applied energy is utilized more effectively and efficiently; such conditions are determined by the relationship between film thickness and film capacity.

Results indicate that the irreducible minimum in time necessary to give the specified degree of activation desired in these experiments was from 0.75 to 1.30 seconds. Exposure periods of 2.70 seconds gave the same degree of activation under conditions which permitted a marked increase in the amount of milk which could be activated per unit of time.

The relative efficiencies of irradiated ergosterol and irradiated yeast for the production of vitamin D milk. W. E. KRAUSS, R. M. BETHKE AND WILLARD WILDER, Depts. of Dairy and Animal Ind., Ohio Agr. Exp. Sta., Wooster, Ohio. Jour. Dairy Science Vol. 17, No. 10, p. 685, Oct., 1934.

Two groups of Holstein cows were fed 60,000 rat units of vitamin D as irradiated ergosterol and 60,000 rat units of vitamin D as irradiated yeast daily. Two other groups of Holstein cows were fed 120,000 rat units of vitamin D from the same sources daily.

Vitamin D assays of the milk produced by these groups of cows showed that the irradiated ergosterol was approximately two-thirds as efficient in allowing transfer of its vitamin D to the milk as was the irradiated yeast.

No satisfactory explanation for this was found. It could not be attributed to a difference in absorption from the intestinal tract since the vitamin D content of the feces and of the bloods was the same regardless of the supplement fed. The existence of different forms of vitamin D having different species effects is considered as a possible explanation, as is also a difference in the "disappearance" into the tissues of vitamin D from the two sources.

Irradiated milk: The reflecting properties and antirachitic activation as affected by the impingement angle of the incident radiation. G. C. SUPPLE, The Dry Milk Company, Bainbridge, N. Y., and M. J. DORCAS, The National Carbon Company, Cleveland, Ohio. *Jour. of Dairy Science* Vol. 17, No. 9, p. 607, Sept., 1934.

This investigation was planned to show the degree to which the activating rays from ultra-violet light are reflected from milk surfaces as this knowledge is important in an understanding of the radiant energy needed to activate milk.

The reflection of ultra-violet light from milk surfaces was of the same order as reflections from water. The extent of reflection increases with increased angle of impingement. At 45 or 77° C. the reflection is constant being 6 per cent for a 30° angle; 13.4 per cent for a 20° angle, 28 per cent for a 15° angle, 34 per cent for a 10° angle and only 3 per cent when the rays struck the milk film at right angles.

Vitamin D studies. E. C. McBEATH. *Amer. J. Pub. Health*, 24: 1028, Oct., 1934.

A group of more than four hundred children in institutions were given various forms of vitamin D milk in an effort to determine the influence of this vitamin on the incidence of dental caries. The milks used included fresh and evaporated, with the vitamin D contents increased by means of a cod liver oil concentrate added direct to the milks. Three different levels of vitamin D were given: 100, 150 and 300 Steenbock units daily. The author concludes that vitamin D is important in the nutritional control of dental caries and that there is a probable correlation between the amount of vitamin D given and the degree of control of dental caries.

The production of vitamin D milk by the feeding of irradiated (cows.) has C. A. SMITH, Director Dry Yeast Dept., Standard Brands in teeth York City. *Milk Plant Monthly*, Vol. 23, No. 5, 1934.

Dr. Smith points out that three methods of increasing the content of milk are available. During 1930-31 more than 50% vitamin A the white infants and over 75 per cent of the negro infants, PHILIP L. New York City Health Stations showed definite signs of State College, Mellanby in England has shown that an abundance of vitamin or delays tooth decay. Rickets cause defective bone and teeth dissolved in min-

Deformed pelves of girl babies as a result of rickets cause untold misery and perhaps death in bearing their children in later life.

Yeast is a food. It contains 50 per cent protein and is rich in ergosterol. Irradiation of yeast changes the ergosterol to vitamin D so that one pound contains 450,000 Steenbock vitamin D units. This yeast has 70 times the vitamin D potency of cod liver oil. The accepted standard for cod liver oil is $13\frac{1}{2}$ Steenbock units per gram (453 grams equal 1 pound).

Feeding yeast to cows improves their general appearance and health. It also stimulates their appetites. Observations of this nature have been made over a long period of time in 25 herds with a total of more than 1,000 cows.

The irradiated yeast is mixed with the grain ration. Low producing cows require less yeast than high producers although high producing cows convert more efficiently the vitamin D of the yeast into the milk. Age, breed, period of lactation and like factors do not influence Vitamin D potency of the milk. Irradiated yeast must be fed to cows for 15 to 20 days before maximum vitamin D potency of the milk is obtained. After 10 days 80 per cent of the maximum is obtained.

A license must be obtained from the Wisconsin Alumni Research Foundation, Madison, Wisconsin, before a dairyman is allowed to feed irradiated yeast. This requires that the dairyman have a high local rating, and when the license is obtained the Fleischmann Laboratories of Standard Brands, Inc., 595 Madison Avenue, New York City supply and cooperate in the successful use of the treated yeast.

Clinical evidence is presented to show that 100 infants selected at random were free from ricketic conditions one month after receiving daily $1\frac{1}{2}$ pints of vitamin D milk (160 Steenbock units per quart).

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ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

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National Institute for Research in Dairying, Reading, England	

ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

BUTTER

X-ray Investigation of the Microcrystalline Structure of Butter-fat.

W. VAN DAM, Agr. Exp. Station, Hoorn, Holland; W. G. BURGERS, Physical Lab. of the Philips Works, Eindhoven, Holland. *JOURNAL OF DAIRY SCIENCE* 18, 1, p. 45, Jan., 1935.

Butter was prepared from cream subjected to various temperatures before aging and the butter was also cooled at different rates and temperatures. X-ray interference exposures were made by the method of Debye-Scherrer.

It was found that the presence of liquid fat in the solid butter could be readily detected when the butter was made with some fats of high melting point. Crystallization of the butter fat during cold storage of the butter could be followed by X-ray analysis. The method did not show much difference between fresh butters made with normal and with very cold wash water.

The Use of Citric Acid and Sodium Citrate in Buttermaking. HUGH L.

TEMPLETON AND H. H. SOMMER, College of Agriculture, Madison, Wisconsin. *JOURNAL OF DAIRY SCIENCE* 18, 2, p. 97, Feb., 1935.

The work of numerous investigators has shown that the addition of citric acid to starter cultures increases the amount of the volatile products which are responsible for the flavor and aroma of the butter made from such starter cultures. The principal flavor and aroma constituents are generally conceded to be methylacetylcarbinol and its oxidation product diacetyl. It has been shown that the quantity of these flavor-producing substances may be increased as a product of the utilization of citric acid by lactic cultures.

Butter made from commercial starter cultures treated with 0.2 per cent of citric acid or its equivalent of sodium citrate at each transfer of the culture, and butters made with the same proportion of citric acid or sodium citrate added to the cream with the starter culture seemed to have a more desirable flavor and aroma than the butter made from cream without such additions. The increase in flavor and aroma was more noticeable when the citric acid or sodium citrate was added to both the cream and the starter culture rather than when added to the starter culture alone. Most of the treated butter showed excellent keeping quality. It was noted that the addition of the citric acid tended to decrease the fat losses in the buttermilk.

Investigations on the Keeping Quality of Butter. RUDOLF HEISS AND KARL ENGEL, Institute of Refrigeration Technique, Technical College, Karlsruhe, Germany. *Milchw. Forsch.* 17, 1-2, p. 8, Feb., 1935.

When the air in cream was displaced by an inert gas and the butter was churned and stored in such gas, the keeping quality of the butter at low temperatures of storage was about three times as good as that for butter stored in air. At higher storage temperatures the influence of inert gas was negligible; hence cold storage cannot be displaced by storage-in-gas, but higher temperatures might be used economically. Butter stored in air at 0°C. (32°F.) kept as well as butter stored with nitrogen gas at 5-6°C. (41-42.8°F.)

The microflora was an important factor in deterioration as indicated by data obtained from casein agar platings. The relative humidity of the storage atmosphere was not a significant factor. The nature of the wrapping paper, whether genuine vegetable parchment, hydrolloid paper, waterproof cellophane, pergamyn or imitation parchment, had no effect when the butter was stored in the dark. Suggestions are made concerning future commercial possibilities of the treatment of cream, churning and storage with inert gases and improvement in equipment, containers and sanitation.

CHEESE

On the Fat and Water Content of Cheese. A. BEYTHIEN, Dresden, Germany. *Milchw. Forsch.* 17, 1-2, p. 1, Feb., 1935.

The author comments on the 1934 German laws and regulations governing cheese with special reference to fat and moisture content. The range in moisture contents of certain cheeses during 1932-1934 determined by the author were as follows: Brie 44.1-60.2 per cent; Camembert, full-fat 43.2-59.6 per cent; half-fat or skim 52.9-67.6 per cent; Altenburger Ziegenkäse, full-fat 48.1-62.7 per cent; half-fat or skim 62.0-73.1 per cent; Romadur 54.0-70.3 per cent; miscellaneous soft cheeses as Edel, Perle der Osmark, Feinkost, Dessert, Delikatess, Schloss and Alpen 47.7-70.9 per cent; Gervais 32.7-56.1 per cent; Roquefort 32.2-55.4 per cent; Neuschateller full-fat 51.9-67.0 per cent, half-fat 62.2-70.9 per cent; Holländer, full-fat 34.5-49.9 per cent, half-fat 41.4-49.0 per cent; Schweizer 22.8-36.0 per cent, and Tilsiter, full-fat 31.0-52.0 and half-fat 39.1-55.5. The average moisture content seems to have increased in recent years and new problems have arisen in connection with process cheese.

On Spotted Cheese. W. GRIMMER AND J. RODENKIRCHEN, Dairy Institute, University of Königsberg, Germany. *Milchw. Forsch.* 17, 1-2, p. 39, Feb., 1935.

The light, grayish-white spots or mottles appearing on cut surfaces of cheese are attributed to the oxidation of the vegetable cheese color, annato,

when potassium nitrate and large numbers of *Bacterium coli* (*Escherichia coli*), *Bacterium pyocyaneum*, (*Pseudomonas aeruginosa*) or *Bacterium vulgare* (*Proteus vulgaris*) are present.

Photometric Measurements of Butter, Butter Colors and Carotin. At the Same Time, a Contribution to the Question of Standardization of Butter Coloring. FR. RICHTER, Institute of Animal Breeding and Dairying, University of Breslau, Germany. *Milchw. Forsch.* 17, 1-2, p. 72, Feb., 1935.

The photometric measurements of five commercial butter colors (three chemical and two vegetable) showed large differences in concentration but only slight differences in the color comparison. The stability of the chemical colors, as determined by sensitivity to light, was superior to that of the vegetable colors. Carotin in an oil solution had somewhat poorer stability than the chemical colors but better than the vegetable colors. The color curves of butter colors and butterfat were decidedly different but between butterfat and carotin there was a marked similarity. Butter coloring studies showed the suitability of carotin for that purpose. The author proposes a fixed carotin content of butter, determined easily photometrically, as a scale for the standardization of the color of butter.

On the Detection of Preservatives in Process Cheese. G. SCHWARZ, OTTMAR FISCHER AND O. KAHLERT, Institute of Chemistry, Prussian Dairy Experiment and Research Institute, Kiel, Germany. *Milchw. Forsch.* 17, 4, p. 170, Aug., 1935.

Three distinct and independent processes are described for the detection of benzoic acid in process cheese, namely, (1) microscopic observations of crystal formation, (2) microdetermination of the melting point and (3) specific color reaction. Photographs of apparatus and characteristic crystal pictures are presented. Benzoic acid was found in 22 of the 135 samples examined.

The Keeping Quality of Butter Depending on Different Packing Materials. A Contribution to the Question of Autoxidative Spoilage of Butter. F. KIERFLE AND A. SEUSS, Chemical and Physical Division, South German Dairy Experimental and Research Institute at Weihestephana, Technical College, Munich, Germany. *Milchw. Forsch.* 17, 4, p. 181, Aug., 1935.

Ordinary commercial parchment paper, special parchment (Ultrament), parchment-like paper (Rowalin), tin and aluminium foil (lined and unlined, impregnated and plain), cellulose hydrate foil (colored and uncolored) were used for wrapping butter. The samples were exposed to the ultra-violet rays from a quartz lamp. The protection of the fat afforded by the wrapper

against the light was measured by a method for detecting the first stages of autoxidation with $N/200 \text{ Na}_2\text{S}_2\text{O}_3$. Ordinary parchment was not as satisfactory as Ultrament, Rowalin, cellophane or metal foils.

CONCENTRATED AND DRY MILKS

Sauerkraut Juice for the Acidification of Evaporated Milk in Infant Feeding. C. V. RICE. Arch. Ped. 51, p. 390, June, 1934.

Evaporated milk acidified with sauerkraut juice from tin containers has been found in a small series of cases to provide sufficient antirachitic factor to prevent or cure rickets in infants. Kraut juice from glass containers did not seem to provide the same protection. The author believes that the advantage of this form of acidified milk lies in the fact that the minerals and vitamins in sauerkraut juice are probably antirachitic and antiscorbutic, thereby eliminating the need for supplementary cod liver oil or orange juice. The formula is palatable, easily digested, economical and simple to prepare.

Color Development in Lactose Solutions During Heating With Special Reference to the Color of Evaporated Milk. B. H. WEBB, Bureau of Dairy Industry, U. S. Dept. of Agr., Washington, D. C. JOURNAL OF DAIRY SCIENCE 18, 2, p. 81, Feb., 1935.

Reproducible color standards for measuring the color of lactose solutions in which heat has produced varying shades of brown have been described and defined in numerical terms according to the Munsell system of color measurement.

The presence of the phosphate radical in lactose solutions during heating has been shown to exert a specific effect in causing darkening in the color of these solutions.

Color development in lactose solutions during heating is increased with increasing concentration of hydroxyl-ions, lactose, amino acids, ammonium salts, phosphate and oxygen. The presence of copper or iron catalyzes the color reaction while tin retards color formation. A very small quantity of formaldehyde increases color while larger amounts markedly restrict color development. Sodium bisulfite will entirely prevent the appearance of color. When amino acids or proteins are present during heating, color is probably due both to the formation of a complex material formed from the lactose and an amino group and to a polymerization of the sugar to lacto-caramel. Either reaction may occur in the range of hydrogen-ion concentrations found in milk.

An effective means of preventing color development in lactose solutions during heating which would be suitable for use in improving the color appearing in evaporated milk during sterilization was not found. However,

the results obtained with lactose solutions substantiate the fact that the objectionable darkening in color of evaporated milk which occurs during storage can be materially lessened by shortening the storage period or lowering storage temperature.

On Dehydration and Hydrate Formation of Lactose. W. MOHR AND J. WELLM, Institute of Physics, Prussian Dairy Experimental and Research Institute, Kiel, Germany. *Milchw. Forsch.* 17, 4, p. 109, Aug., 1935.

The water of crystallization of lactose was lost at 87° C. (188.6° F.) at an atmospheric humidity from about 3 grams per cubic meter or lower, while at 100° C. (212° F.) evaporation took place at a humidity between 8 to 14 grams per cubic meter. The lactose anhydride, water-free lactose obtained by dehydration at 100° C. (212° F.) in vacuum, proved decidedly hygroscopic at room temperature and ordinary atmospheric humidity and was converted back to the hydrate immediately. The evaporation of lactose solutions at 70° C. (158° F.) and 90° C. (194° F.) yielded thin layers of water-free lactose which was not hygroscopic in air at 20° C. (68° F.) with a humidity of 8 grams per cubic meter. This water-free lactose took up water over and above the amount necessary for hydrate formation only in air almost saturated with humidity (17 grams per cubic meter), and in storage at ordinary atmospheric humidity (5.2 grams per cubic meter) the water was given up almost completely. Longer storage in very moist air led to hydrate formation. The water contained in lactose "glass" was only absorbed since it was given up under conditions which do not permit the escape of the water of hydration. The alpha lactose hydrate and anhydride, ten minutes after dissolving, showed practically the same specific rotation of +82.2° and +79.6° while the lactose and lactose "glass" obtained in a thin layer from solution at 70° C. (158° F.) and 90° C. (194° F.) showed +60.3°, +58.1° and +56.6°. The Debye-Scherrer X-ray diagrams of the lactose preparations varied as did those of the alpha hydrate and the lactose obtained in thin layers from solution. The alpha lactose anhydride gave a characteristic X-ray diagram. The lactose "glass" showed only a broad, indistinct interference ring and was solidified amorphously.

MILK

The Effect of Alfalfa Hay on Milk Flavor. EARL WEAVER, A. H. KUHLMAN AND E. L. FOUTS, Oklahoma Agr. Exp. Station, Stillwater, Oklahoma. *JOURNAL OF DAIRY SCIENCE* 18, 1, p. 55, Jan., 1935.

A good quality of alfalfa hay was fed to cows just after milking and at varying intervals before milking. It was found that the alfalfa hay imparted a distinct flavor to the milk when fed from $\frac{1}{2}$ to 1 hour before milking.

The intensity of the off-flavor varies with the quantity of hay fed. Milk from small Jerseys is affected more seriously than that from large Holsteins when the cows are fed the same quantity of hay. Aeration of the milk removes only part of the flavor imparted to it by the hay and cooling seems to be ineffective.

Significant Aspects of a Recent Official Survey Concerning the Household Use of Milk in Philadelphia. SENECA EGBERT, Univ. of Pennsylvania, Philadelphia, Pa. *Amer. J. Pub. Health* 25, 7, p. 789, 1935.

A survey was made during the summer of 1934 by the Department of Agricultural Economics of Pennsylvania State College and the U. S. Department of Agriculture. Similar surveys were made in 1924 and 1929.

Records were obtained from 3,004 families residing in the city and from 409 in the suburbs. Daily average per capita consumption of fluid milk in the home decreased from 0.68 pints in 1929 to 0.60 pints at the time of this study. It is unlikely that the decline was as great as this, since a number of factors did not remain fixed. The weekly average per capita consumption for those families reporting purchase and use was 2.25 quarts of fluid milk, a little less than 5 ounces of butter, and a little more than 0.5 pint of ice cream. Only 92.3 per cent of the families purchased fluid milk and only 92.7 per cent bought butter. Almost 50 per cent of the families bought some condensed or evaporated milk and nearly 40 per cent purchased ice cream. The relation between milk consumption and factors such as nationality, per capita income and size of family is discussed.

From 80 to 90 per cent of the children between the ages of 1 and 10 years drank milk regularly; at from 9 to 10 years there was a decline; and from 9 to 11 years there apparently was a decline in the percentage who drank milk habitually and a corresponding increase in the percentage who never drank milk. Thirteen per cent of children under 12 years, 30 per cent of adolescents between 12 and 18, and 83 per cent of mothers only occasionally or never drank milk. Generally speaking, the number of people who regularly drink milk has continued to increase during the last 10 years. Credit is given to organizations and agencies stressing the use of milk, and need for further work is indicated.

On "Milking Through" Cows, the Qualities and Composition of Their Milk and the Adaptability of an Austrian Alpine Breed for the "Finish Milking" Industry. WOLFGANG SCHEIMPFLUG, Institute for Dairy and Agricultural Bacteriology, College of Agriculture, Vienna, Austria. *Milchw. Forsch.* 17, 4, p. 118, Aug., 1935.

The practice of continuing cows in production beyond their normal lactation period is common abroad. Certain establishments milk the cows as long as possible. Statistics are given for 5,192 animals and show that the Monta-

foner and Oberinntaler cows milked the longest; the Simmentaler, Unterinntaler and Pinzgauer next; and the Niederungsvieh and Blondvieh the shortest time. Data are also reported on a few Landschlag (Schecken), Tux-Zillertaler and Meraner cows. The Oberinntaler breed, besides its long and high milk productivity, is also low in original cost and more resistant to disease. The experimental animals were divided into two groups, with four cows in each group, the control consisting of animals which had calved from one to three months previously while the other group included cows that had been in milk for four to seven years. Data are given in detail on milk production, fat percentage, size of fat globules, creaming ability, specific gravity, total dry matter, fat-free dry matter, viscosity, lactose, protein, conductivity, calcium, chlorine, potassium, sodium, phosphoric acid, acidity, freezing point depression, rennet coagulability, total bacterial content, acid formers, *E. coli*, anaerobic spore-formers, reductase, Schardinger ferment, and diastase. The differences between the groups are not significant in most cases.

Wooden Milk Container and its Usefulness for Transport. HUGO KÜHL, Berlin, Germany. *Milchw. Forsch.* 17, 4, p. 99, Aug., 1935.

A new type of oaken vessel for transporting milk is described which the author claims is preferable to tinned iron cans, especially as regards the effect on milk.

Relation of the Retail Price of Milk to Production Costs. THOMAS PARAN, JR., State Health Commissioner, Albany, N. Y. *Amer. J. Pub. Health* 25, 3, p. 239, 1935.

The legislature of New York made the Health Commissioner an *ex-officio* member of a milk control board established in 1933. A statistical study is presented of production costs, utilization of milk, variation in efficiency of operation of dealers, and distributors' costs. The author claims that state regulation is of value to the producer. The conclusion is drawn that if substantial reductions in the cost of milk to the public are to be made, they must be accomplished through more efficient operations or the elimination of expensive services.

Nutrition and Health and the Price of Milk. JAMES A. TOBEY, The Borden Company, New York, N. Y. *Amer. J. Pub. Health*, 25, 2, p. 197, 1935.

Although milk is recognized as our most important food, the consumption in this country is now far below the acknowledged standards of an adequate diet. The consumption of milk in the United States should be increased at least 70 per cent. The beneficial effects of greater milk consumption upon physical welfare, the factors influencing consumption and the price of milk

are discussed. The economy of milk as a food is compared to that of other foods. At its present price or even at double that price, milk gives a better return on the nutritional investment than any other food. In the author's opinion, the solution of the economic problem of the dairy industry is not through a decrease in production, but by an increase in consumption of milk and dairy products, an endeavor which deserves the active cooperation and assistance of all public health officials.

The Proper Filling and Capping of Sterilized Bottled Chocolate Milk.

A. H. WORTH, Chemical Director, Crown Cork and Seal Co., Baltimore, Md. *The Dairy World*, 14, 1, p. 51, June, 1935.

In the bottling of chocolate milk which is to be sterilized (usually for 17-19 minutes at 235°-240°F.) it is necessary to allow sufficient "head space" under the crown seal and above the liquid to provide for expansion due to the heating. The amount of space required will vary with the filling temperature, being greater where the milk is filled cold and less where the milk is filled hot. A table is given showing the coefficient of expansion for water and for chocolate milk and the volume occupied by 1 gram of chocolate milk at various temperatures.

If sufficient head space is not provided in filling the bottles or in choosing a proper bottle size, then there will be a high loss in sterilizing due to blown off caps and burst bottles. A safety factor above the minimum actually required of about 0.2 fluid ounces (regardless of bottle size) is suggested.

For the sealing of chocolate milk bottles a cap, made of tin of similar metal fitted with a cork ring capable of holding 70 pounds pressure, is suggested. These caps are now available in disc form, stacked in tubes and are formed over the lip of the bottle by an automatic capping machine which gives the appearance of a preformed crown on the capped bottle.

A Chart to Aid in Scoring Milk Flavor. E. L. FOUTS AND EARL WEAVER, Oklahoma Agricultural Experiment Station, Stillwater, Oklahoma. *JOURNAL OF DAIRY SCIENCE* 18, 1, p. 51, Jan., 1935.

A chart has been devised to assist persons scoring milk for flavor to ascribe some numerical significance to different gradations of a defect. Three degrees of intensity are used to describe any flavor defect, the terms "slight" and "very" being employed to reveal the upper and lower gradations in the flavor. A definite numerical range is assigned to each class. In this manner the chart aids materially in standardizing the numerical scoring of milk for flavor.

The Temperature of Milk Immediately after Milking and Strainer Capacity. A. C. DAHLBERG AND H. L. DURHAM, New York Agr. Exp. Station, Geneva, N. Y. N. Y. Agr. Exp. Station Bull. No. 639, Jan., 1934.

Comparisons were made between the temperature of hand-milked milk and milk drawn with two different milking machines. It was found that the temperature of milk is dependent upon the temperature of the barn, the total weight of milk given by each cow, and the method used for milking. Because strainer capacity is so dependent upon milk temperature, variations in strainer capacity may be attributed to one or more of the above mentioned factors.

This study showed that milk drawn by hand from heavy producing cows in warm barns had the highest temperature and strained the fastest.

How to Keep the Growing Child Interested in Milk. H. K. DUGDALE, Vice-Pres., Van Sant, Dugdale and Co., Inc., Baltimore, Md. Dairy World, 12, 10, p. 20, March, 1934.

Contests to exemplify excellency in athletic or physical training in connection with the school work of children is recommended as a means of increasing the consumption of milk. The plan calls for prizes to be awarded to the boys or girls with the highest marks, and who present with their athletic or physical training grade certificate a statement signed by their parent or guardian that they drink milk with every meal.

Such contests link the drinking of milk with outstanding athletic performance, and during the period of the contest and for years afterward those school children participating, and even those who do not, will hold this thought embedded in their minds.

The Cost of Producing Milk in Rhode Island. J. L. TENNANT, Rhode Island Agr. Exp. Station, Kingston, Rhode Island. Rhode Island Agr. Exp. Sta. Bull. 241, Jan., 1934.

The average cost of producing 100 pounds of milk on 39 Rhode Island farms during the 12 months from February 1, 1932, to January 31, 1933, was given.

Milk Distributors' Costs and Profits in New York State. LELAND SPENCER, N. Y. State College of Agr., Cornell Univ., Ithaca, N. Y. Milk Dealer, 23, 2, 3, 4, p. 43, p. 35, p. 31, Nov., Dec., 1933, Jan., 1934.

This is a preliminary report to the New York State Milk Control Board based on returned questionnaires from 30 distributors in New York City and from 29 distributors in the upstate cities.

These questionnaires called for sales, costs, and profits in the months of June, July, and August, 1933, and for balance sheet information as of De-

ember 31, 1932. Comparative operating figures for June, July, and August, 1932, and balance sheet information for December 31, 1931, also were requested.

A total of 10 tables of figures are presented. This data is in the form of averages for groups of companies. A wide variation existed among the several concerns, however, for example, the amount of profit or loss per quart of milk in August, 1933, varied among the New York companies from a profit of \$.0035 to a loss of \$.0128. Among the distributors doing business in the larger upstate cities, the net profit or loss per quart varied from a profit of \$.0105 to a loss of \$.0165.

Committee comments: The complete publication upon which these articles are based is the Report of the Joint Legislative Committee to Investigate the Milk Industry, Legislative Document No. 114 (1933, pp. 473).

An Analysis of the Fresno Milk Market. J. M. TINLEY, Univ. of California, Agr. Exp. Station, Berkeley, California. California Agr. Exp. Sta. Bull. 559, Oct., 1933.

The purpose of this study was to analyze the economic factors affecting the long-time stability of the Fresno milk market and to ascertain possible means of affecting economies through reorganization of present methods of handling milk in Fresno. Data were secured from dealers, producers, the State Department of Agriculture, and the Fresno Health Department. Twenty-three tables of data are presented in this comprehensive study of 59 pages.

Laboratory Examinations of Milk Handlers. EARLE K. BORMAN, D. EVELYN WEST AND FRIEND LEE MICKLE, Conn. State Dept. of Health, Hartford Conn. Amer. J. Pub. Health, 25, 5, p. 557, 1935.

Based upon statistics for the entire United States from 1880 to 1933 and for Connecticut from 1918 to 1933, the epidemiological importance of milk-borne diseases traced to human carriers and cases is discussed. The necessity for remedial measures to control milk-borne infections is indicated.

Opinions were obtained from 205 persons in authoritative positions on the value of routine laboratory examinations of specimens from milk handlers; also comments of these officials concerning the value of the Connecticut program are recorded. The conclusion is made that periodical physical examinations of milk handlers supplemented by certain routine laboratory tests are desirable for the handlers of raw milk and for the employees in pasteurization plants. The total actual cost of 24,487 laboratory examinations in Connecticut in 1933 was \$7,966.

The laboratory examinations discussed are: Throat and nose cultures for virulent diphtheria organisms and for beta hemolytic streptococci, sputum for *Mycobacterium tuberculosis*; feces and urine for typhoid, paratyphoid,

dysentery, and food poisoning bacteria; Widal tests; feces for vegetative or encysted forms of *Endamoeba histolytica*. The role of the laboratory in a complete routine examination of milk handlers is discussed and a program suggested.

A Modified Technic for the Detection of the Escherichia-Aerobacter Group in Milk. ANDREW MOLDAVAN, Guaranteed Pure Milk Co., Lt., Montreal, Que., Canada. Amer. J. Pub. Health, 25, 9, p. 1932, 1935.

The use of agar-sealed fermentation tubes is described. Into ordinary test tubes are placed 9 cc of 2 per cent brilliant green lactose peptone bile and sterilized. The medium is inoculated with 1 cc of milk, the tube is rolled between the hands to insure a uniform distribution of the inoculum, and 2 cc of 2 per cent agar are poured slowly along the side of the tube where it cools rapidly and forms a solid plug. The following advantages are claimed: (1) Results are positive or negative for 1 cc of milk, whereas, when small inverted gas tubes are used, the amount of milk introduced into the small tube varies from 0.1 to 0.5 of inoculum. (2) Traces of gas are more noticeable in agar-plugged tubes than in submerged and inverted tubes. (3) In positive samples, gas will be detected within 8-16 hours in agar-plugged tubes, whereas the inverted tube technic requires a 48-hour incubation period.

Acidophilus Kefir, Composition and Bacterial Flora. O. K. PALLADINA, T. A. KROTOVA AND W. A. MASJUKEWITSCH, Dairy Lab., National Institute of Nutrition, Leningrad, U.S.S.R. Milchw. Forsch. 17, 1-2, p. 25, Feb., 1935.

A satisfactory and uniform kefir can be prepared by using mixtures of selected pure cultures (70 per cent symbiotic streptococci, 25 per cent *Lactobacillus acidophilus* or *L. caucasicus* and 5 per cent lactose-fermenting yeasts). Total and volatile acidity, diacetyl, alcohol from milk and carbohydrates and proteolysis caused by various bacteria, with and without symbionts and/or yeasts, are reported as well as the comparison of kefir produced by various cultures.

Investigations of the Actions of Microorganisms on Milk. CONSTANTINO GORINI, Director, Bacteriological Lab., Royal Agr. College, Milan, Italy. Milchw. Forsch. 17, 4, p. 87, Aug., 1935.

In studying the coagulating and digesting activities of bacteria on milk, the author used a method of flooding the surface of inoculated agar plates with sterile milk. He used 115 cultures of pathogenic streptococci (16 species), 33 cultures of mastitis streptococci, 22 cultures of *Bact. typhi flavum*, a yellow variant of the typhoid bacillus and 8 variants of *Eberthella typhia*. The detection of the enzymes, chymase (coagulating) and protease

(digesting) was much more satisfactorily accomplished by this procedure than by the more common methods. The author suggests that the results obtained may have a bearing upon the interpretation of relationships or differences between various species or strains of bacteria.

Influence of Salt on the Growth and Cell Form of Lactic Acid Bacteria, *E. coli*, *A. aerogenes* and some other Common Milk Bacteria. W. HENNEBERG AND HANNA KNIEFALL, Institute of Bacteriology, Prussian Dairy Experimental and Research Institute, Kiel, Germany. *Milchw. Forsch.* 17, 4, p. 146, Aug., 1935.

The effect of sodium chloride on the growth and morphology of 68 cultures of common milk bacteria was studied. Milk, lactose agar, and china blue lactose agar were used as substrates. The growth in the different media and at different salt concentrations varied with the different strains and species. Each culture showed distinct and individual responses to the environment. Variations in growth rates or morphology taking place in dairy products such as butter and cheese where salt is a factor, and the interpretation of microscopic pictures of storage are very significant. The observations made by the authors should be very helpful to those investigators interested in the microbiology of dairy products.

Studies on Lactic Acid Streptococci. V. On the constancy of fermenting power of fecal streptococci in many years of milk culture. KARL J. DEMETER AND R. PFUNDT, Bacteriological Section, South German Dairy Experimental and Research Institute, Weißenstephan Technical College, Munich Germany. *Milchw. Forsch.* 17, 1-2, p. 44, Feb., 1935.

Nine cultures of lactic acid streptococci of fecal origin were studied after more than eight years of cultivation in milk in order to determine the constancy of their fermenting power, especially for carbohydrates. The same media and methods used eight years previously were employed. No noteworthy change in fermenting capacity was observed. Apparently milk is an excellent medium for the preservation of cultural and biochemical characteristics of these fecal streptococci. The close affinity of *Streptococcus faecalis* and *S. lactis* is suggested.

On a New Execution of Roll Tube Culture and its Usefulness for the Determination of the Germ Count in Milk. HELMUT DAMM. Institute of Bacteriology, Prussian Dairy Experimental and Research Institute, Kiel, Germany. *Milchw. Forsch.* 17, 1-2, p. 51, Feb., 1935.

A modification of the Esmarch roll culture method is described and the apparatus illustrated. Statistical analyses of data obtained by this new

rapid method are reported and indicate that it has an advantage over the Burri method and compared more closely with standard plate methods.

Studies of Correlated Human and Bovine Brucellosis. Statistical and Serological. R. V. STONE AND EMIL BOGEN, Los Angeles, California. Amer. J. Pub. Health, 25, 5, p. 580, 1935.

An attempt was made to determine the incidence of infection with *Brucella abortus* among persons consuming raw milk from three herds supplying three institutions for the cure of tuberculosis patients in Los Angeles County.

The incidence of infection of the cattle varied from 6 to over 50 per cent, as revealed by agglutination titers of 1/50 or higher, with an average of nearly 30 per cent showing agglutination in titers of 1/100 or higher.

During the first half of 1930, more than 1,200 specimens of blood were taken from patients of these three institutions and tested for agglutinins of *Br. abortus* by the macroscopic method recommended by the University of California Committee. The results indicated that the ingestion of raw milk obtained from cows infected with contagious abortion and showing positive tests for agglutinins to *Br. abortus* in their blood is responsible for the development of similar agglutinins in the blood of some consumers. This occurred in about 8 per cent of those continuously exposed to the ingestion of heavily infected raw milk, but varied with duration of exposure, amount of infection in the herd and amount of raw milk consumed. Tuberculosis or other disease apparently had no effect upon the development of such agglutinins except in so far as they might affect the amount of milk consumed. The development of such agglutinins was not found to exercise any marked effect on the course of the tuberculosis. More than half of the patients developing agglutinins to *Br. abortus* gave no other manifestation of the infection. About one-eleventh of them manifested clinical symptoms warranting a diagnosis of undulant fever.

Standardization of the Methylene Blue Reduction Test by the use of Methylene Blue Thiocyanate. II. R. THORNTON AND R. B. SANDIN, University of Alberta, Edmonton, Alberta, Canada. Amer. J. Pub. Health, 25, 10, p. 1114, 1935.

It is difficult to duplicate the standard tablets of methylene blue certified by the Commission on Standardization of Biological Stains if the methylene blue salt used is to be the methylene blue chloride. Joint studies by a number of laboratories in the United States and Canada of samples of methylene blue thiocyanate distributed through the chairman of the Commission on Standardization of Biological Stains have shown that the thiocyanate and chloride of methylene blue are identical in their reducing properties.

It is recommended that (1) methylene blue thiocyanate be substituted

for methylene blue chloride in the standard tablets used in the methylene blue test because of the reproducibility of the former dye, and that (2) one part of dye to 300,000 parts of milk be adopted as the standard concentration in this test.

An Outbreak of Milk-borne Hemolytic Streptococci Infection. ARTHUR W. NEWITT, JEAN W. GLASSEN AND R. W. PRYER, Michigan Department of Health, Lansing, Mich. Amer. J. Pub. Health, 25, 7, p. 804, 1935.

An outbreak of sore-throat in Petersburg, Michigan, during September, 1934, was traced to the use of raw milk. There were 186 known cases and 6 deaths. The attack rate was 28.6 per 100 inhabitants, while the fatality rate was 3.22 per 100 cases. The outbreak was caused by the transmission of hemolytic streptococci from an infected quarter of one cow which was probably infected by a hemolytic streptococcus of human origin. None of the cultures from the milk or human throats was entirely characteristic of *Streptococcus epidemicus*. The disease produced by the Petersburg strain differed materially from scarlet fever in its usual clinical manifestations and more nearly resembled typical sore throat.

Evidence that the infecting organism was a variant rather than a fixed strain of scarlet fever streptococcus is presented.

Media Suggested as Substitutes for the Standard Agar used in Routine Milk Control Work. ROBERT S. BREED, New York Agr. Exp. Station, Geneva, N. Y. J. Amer. Pub. Health, 25, 5, p. 663, 1935.

Bacteria that do not grow readily on the ordinary standard agar are frequently present in milk samples and may cause gross errors in bacteria counts. The formula of two agars that have been suggested as substitutes for the present standard nutrient agar are a Tryptone glucose skimmilk agar developed by Bowers and Hucker in this country, and an English modification of standard agar primarily developed at the Dairy Research Institute, Reading, England, and in the laboratories of the United States Dairies, London, England. The composition of the Tryptone glucose skimmilk agar is Tryptone 5 grams, glucose 1 gram, agar 15 grams, fresh skimmilk 5 cc and distilled water 1,000 cc. The English modification of standard agar consists of adding 5 cc of good quality skimmilk per 1,000 cc of sugar just before autoclaving. Detailed directions are given for the preparation of these two media.

Isolation of Streptococci from Milk. WILLIAM M. GROESBECK, Steuben County Laboratories, Hornell, N. Y. Amer. J. Pub. Health, 25, 3, p. 345, 1935.

The isolation of streptococci from milk is frequently difficult because of the presence of other bacteria. The author adopted a technic for use in

milk analysis which previously has been used by other workers for determining the streptococcus content of feces. This method is most satisfactory with composite or herd samples.

While 1 cc of a thoroughly mixed sample may be used, preferably 1 cc of the gravity cream is emulsified in a test tube containing 10 cc of a freshly prepared sterile 1 per cent solution of sodium carbonate of tested purity. When the mixture is incubated at 37° C. over night, growth of the streptococci occurs and gram negative bacilli are destroyed. Sub-cultures from the carbonate solution are then made upon blood agar plates and the isolation completed in the usual manner.

Undulant Fever. *Lancet*, 228, p. 145, June 22, 1935.

The *Lancet* discusses editorially the prevalence of undulant fever and the importance of more adequate diagnosis and control, with particular reference to the paper by Beattie, Smith and Tulloch. Methods of treatment of the disease have been rather unsatisfactory, on the whole, although certain investigators support the use of various vaccines. The value of pasteurization in the prevention of undulant fever is shown by the fact that wherever pasteurization is compulsory cases of this disease are never traced to the milk.

An Investigation of Kuban Fermented Milk. V. M. BOGDANOFF, *Dairy Prod. Res. Inst., Moscow, U. S. S. R.* *J. Dairy Res.* 5, 2, p. 153, April 1934.

A study was made of Kuban fermented milk (Kuban being adjacent to the district of Don in South Russia).

Microscopic examination of the curd showed organisms of the following types: (1) granular rods of varying length, (2) streptococci, appearing mostly as diplococci, and (3) yeasts. The streptococci and rods predominated.

As a means of isolating the two former organisms, inoculations were made on plates of the following media: (1) beef peptone, (2) whey agar, and (3) milk-peptone gelatin. As has been previously observed with lactobacilli, neither organism manifested any growth on the first medium, while both showed poor growth on the whey agar. On milk-peptone gelatin both organisms formed normal colonies. In addition to the above inoculations, the Kuban fermented milk was plated on malt agar. From these plates three separate species of yeast were isolated, which could be distinguished from one another partly by their morphological and partly by their physiological characters.

The following summary is given:

1. Kuban fermented milk is characterized by two types of fermentation, *i.e.*, lactic acid fermentation and alcoholic fermentation.
2. The micro-flora of such milk always embrace the following components:

(a) a lactic acid producing streptococcus resembling *Str. hollandicus*; (b) a lactic acid producing rod of the type of *L. bulgaricus*; and (c) three types of yeast.

3. There is close symbiosis between the component organisms. The two lactic acid producing organisms can function normally in the absence of the yeasts. The latter, however, prolong the vitality of the starter and also impart a specific taste to the fermented milk.

Inoculation of the natural starter with *Str. lactis* results in a rapid multiplication of this organism and an overproduction of acid, which imparts to the fermented milk the taste of ordinary sour milk. A similar undesirable taste is produced if the fermented product is prepared from raw, instead of heated, milk.

Has Sanitation of Certified Milk any Practical Value? C. E. NORTH, New York City, *Certified Milk*, 9, 93, p. 3, and 94, p. 6, 1934.

In an effort to determine whether or not the sanitary precautions required for the production of high grade milk has any value other than esthetic, the author supervised the analyses of various grades of milk sold in Boston, New York, Philadelphia and St. Louis. The test employed consisted of heating the milk to be tested to 82.2° C. (180° F.) for 10 minutes then cooling to about 38° C. (100° F.). Twenty-cubic centimeter samples were then placed into each of ten Smith fermentation tubes and incubated at 37° C. (98° F.). Observations after 6 to 48 hours showed the presence or absence of spore forming types which induced either proteolysis or the formation of gas. The former types come largely from hay, barn dust and utensils, the latter from fecal contamination. Some evidence is available to show that proteolytic types may also be of intestinal origin.

With a few exceptions milk produced under the conditions of certified milk showed no fermentation in any of the ten tubes after 24 hours; Grade A milk rarely showed more than one tube in ten with gas after 24 hours, whereas ordinary market milk usually showed from five to ten tubes with gas in 10 to 18 hours.

The organisms responsible for this gas fermentation are considered to be *B. Welchii* which are intimately associated with intestinal inflammation, diarrhea, fever, nausea, jaundice and other complications of infant consumers of the milk.

Prevention and Eradication of Bang's Disease. W. W. DIMOCK, Kentucky Agr. Exp. Station, Lexington, Kentucky. *Kentucky Agr. Exp. Sta. Cir. No. 41*, Jan., 1934.

This circular discusses practical methods for the eradication of contagious abortion.

The New Method of Plate Count. HUGO JONE, Formerly Chief Chemist and Bacteriologist, Empire State Dairy Co., Brooklyn, N. Y. *Amer. Creamery and Poul. Prod. Rev.*, 78, 7, p. 222, 1934.

The author states that plate counts on pasteurized milk made according to the procedure in "Standard Methods" are generally too high, when compared with the plate count on the corresponding raw milk. This is due to the fact that most of the lactic acid forming bacteria are destroyed during pasteurization, while in raw milk the lactic colonies do not fully develop at an incubation temperature of 37° C. for 48 hours.

This error may be corrected by incubating as directed under the heading "Verification Methods,"* namely at 20° C. for 72 hours, and at 37° C. for 48 hours. The two incubations would be used jointly in the two tests.

Studies on the Leucocyte Content of Milk Drawn from *Brucella abortus* Infected Udders. C. C. PROUTY, Washington Agric. Exp. Station, Pullman, Washington. *J. Bact.* 27, 3, p. 293, 1934.

A study was made of the leucocyte content of the milk from 18 abortion-infected cows in relation to the presence of *Br. abortus* within the udder. Of the 72 quarters, 21 were found by cultural methods to harbor the specific organism, and in the remaining 51 quarters negative cultural findings were obtained. The leucocyte counts of the milk from the 21 infected quarters and the 51 non-infected quarters were 355,000 and 343,000 respectively. If the high leucocyte counts from two streptococcus mastitis cases were omitted, averages of 145,000 and 185,000 respectively were obtained. Similar average leucocyte counts were obtained from a study of samples collected from an abortion-free herd. The conclusion is drawn that there is no significant difference in the leucocyte counts of milk from *Br. abortus* infected udders and of milk from animals free from the disease.

All samples of milk negative for agglutination reactions in amounts of serum less than 0.08 cc. gave negative cultural findings for *Br. abortus*.

Passage of Bovine *Brucella* through Swine. H. L. GILMAN, C. H. MILKS, AND R. R. BIRCH, Cornell University, Ithaca, N. Y. *J. Infect. Diseases*, 54, 2, p. 171, 1934.

Although the organisms responsible for undulant fever, malta fever in man, and abortion in cattle and goats have been arbitrarily classified according to their origin and certain biochemical characteristics, the exactitude of the methods of differentiation have never been uniformly successful. There has been some question as to whether a strain ordinarily classified as a bovine type might be transformed to a porcine type by inoculation and growth in swine.

* Committee comments: These methods, described on pp. 42-43, Standard Methods of Milk Analysis, 6th edition, 1934, call for incubating plates at 20° C. for 72 hours, and at 55° C. for 24 hours.

An attempt was made to determine whether the passage of bovine strains of *Brucella* through a series of sows would induce these strains to assume the characteristics of the porcine type as determined by the usual dye-tolerance tests. One strain was passed through a series of two hogs; two strains through two series of five hogs each, and one strain through a series of six hogs. At no time was there any evidence of a transformation of the bovine type to the porcine type as determined by the reaction of the strains to the presence of basic fuchsin or thionine in the mediums in dilutions of 1:50,000.

Undulant Fever in New York State. RUTH GILBERT AND MARION B. COLEMAN, State Dept. of Health, Albany, N. Y. *Jour. Infect. Diseases*, 54, 3, p. 305, 1934.

Data accumulated during the past seven years indicate that cattle or dairy products are the source of the incitant in nearly all of the cases of undulant fever in New York State. In contrast to the conditions reported in certain European countries and in parts of the United States, infection from goats and hogs is apparently of negligible importance in New York. Blood specimens from 1290 cows and milk or cream from 383 cows have been studied. The milk and cream samples were from 68 herds which had been suspected of responsibility for known cases of undulant fever. Evidence of infection with the *abortus-melitensis* group was demonstrated in at least one animal, and usually in a considerable percentage, of them, in each of 56 herds. It is estimated that 18 per cent of the animals in the state are infected.

The incidence of undulant fever in New York is shown by the State Health Department records for 1930, 1931, and 1933 to be 165, 171, and 223 cases respectively.

There were 88 strains of the *abortus-melitensis* group isolated either from cow's milk or human blood. Each culture showed the usually accepted characteristics for the bovine strain.

Milk Control and Public Health. EDITORIAL. *Amer. J. Public Health*, 24, 1, p. 46, 1934.

There is no real surplus of milk production in the country if the nutritional needs of the population are considered instead of the present paralysis of buying power which has reduced by 25 per cent the milk consumption in some areas. Governmental control of the milk production and prices will fall short of its potential good if advantage is not taken of the opportunity to promote the sanitary quality of the milk left on the market. Those concerned only with the economic aspect of milk control neglect the public health aspect. Health authorities thus far have had no voice in milk marketing agreements. The milk supply of most cities is not yet of a uniformly satisfactory sanitary quality. If there must be curtailment of production it

should be directed along lines which will eliminate the poor quality product and hence induce an increased consumption for the remainder. The elimination of tuberculosis cattle and of cows suffering from contagious abortion afford a good starting point in a curtailment program.

Bovine Tuberculosis in the British Isles. EDITORIAL. Amer. J. Public Health, 24, 2, p. 142, 1934.

Reports from the Peoples League of Health show that during the years 1920-1931 there have been 25,166 human deaths in England due to the bovine tubercle bacillus. Approximately 40 per cent of the cattle of England are reactors to the tuberculin test and about 2.5 per cent are infective. Udder tuberculosis is most dangerous from the human standpoint but pulmonary tuberculosis is more important from the standpoint of spreading the disease among cattle. Confirming findings of earlier investigators the report concludes that infection of humans with bovine tuberculosis takes place mostly during the milk-drinking period of 1 to 5 years.

Similar studies in Scotland show that tuberculosis of bovine origin is even more wide spread. It is estimated that 70 per cent of the non-pulmonary tuberculosis patients become infected prior to 15 years of age, and that in 90 per cent of these either bone, joint or abdominal tuberculosis becomes manifest. It is estimated that 80 per cent of the abdominal, 35 per cent of the bone and joint, and 64 per cent of the cervical gland tuberculosis in Glasgow, Scotland is of bovine origin.

Further Investigations on the Determination of the Hydrogen Ion Concentration of Milk by the Colorimetric Method. G. SCHWARZ AND OTTMAR FISCHER, Institute of Chemistry, Prussian Dairy Experimental and Research Institute, Kiel, Germany. Milchw. Forsch. 17, 4, p. 158, Aug., 1935.

Instead of the usual color standards of inorganic buffer solutions, milk sera are prepared by using normal sweet milk, to which increasing amounts of sour milk are added to give milks of varying acidity. The samples are treated with methanol (20 ml. milk to 30 ml. methanol), placed in the refrigerator for 30 days and then filtered. The pH of each serum is then determined electrometrically, indicator is added, and the sera are placed in sealed, glass tubes to fit in a color comparator as standards. These standards are good for six months. The indicator solution consists of 20 milligrams brom cresol blue, 50 milligrams methy red and 100 milligrams brom cresol purple dissolved in 1000 milliliters neutral methanol. To each 10 milliliters of serum, 1 milliliter of indicator is added. Samples of sera to be tested are prepared with methanol in the manner indicated above. Measurements can be made with an accuracy of about 0.1 pH within limits of pH 5.6-6.7.

A Gravimetric Micromethod for the Determination of Milk Fat and Dry Matter. G. GORBACH AND R. KADNER, Biochemical Institute, Technical and Mining College, Graz-Leoben, Graz, Austria. *Milchw. Forsch.* 17, 4, p. 190, Aug., 1935.

A new apparatus is described and pictured for the micro-determination of milk fat and dry matter by ether extraction. The method is much faster than macromethods with a Soxhlet extractor. The maximum error was 0.07 per cent for fat content, but somewhat greater for dry matter.

Twin Pots of Gold. ESTHER MARTIN, Nutritionist, National Dairy Council. *National Butter and Cheese Journal*, 26, 24, p. 10, 1935.

Per capita consumption of cheese in the United States is compared with that of certain European countries. Some of the literature on the nutritive value of cheese is reviewed to show that although the food value of cheese varies with its composition and its method of manufacture, still the common varieties are high-energy foods and excellent sources of protein, calcium, phosphorous, and vitamin A. Pleasing and distinctive flavors of cheese have a favorable effect on its digestion.

An Experiment in First Class Protein. CORRY MANN—with introduction by F. GOWLAND HOPKINS. *Lancet*, 228, p. 145, Jan. 19, 1935.

In introducing Dr. Corry Mann, Sir F. Gowland Hopkins points out that it has been generally accepted that animal proteins are superior to vegetable proteins in human nutrition. The study conducted by Dr. Mann on himself is interesting and points to a need for further controlled studies along similar lines.

The study described was undertaken to determine the minimum protein requirements for an adult, and also to discover the relative efficiency of milk protein compared with other forms of protein. A basal diet composed of 2191 calories, providing 52.88 grams of animal protein (70 per cent of total protein), and including 21 ounces of milk, was taken for four months. At that time 10 ounces of milk were withdrawn from the diet (reducing the protein to 43.48 grams and this reduced diet was taken for six weeks. At the end of this period a steady fall in weight and increased fatigue were observed. After a return to the basal diet, lasting three months, another diet was substituted in which the protein was reduced to 41.80 grams by deducting meat and cake. After several weeks no loss of weight or fatigue were noticed by the subject. A further period on the reduced milk diet confirmed the experience of the first period. From this study it appear that 21 grams of milk protein in an otherwise adequate diet is sufficient to maintain general health even though the total protein has been reduced to 60.65 grams daily. "The protein of milk appears to be of more value for purposes of nutrition than the protein of meat."

In conclusion Dr. Mann stresses the fact that commercial pasteurized milk was used exclusively and was not especially selected for the experiment. He states further that he knows of "no evidence in support of the contention that the nutritive value of milk, as a whole, or of its vitamins or of its protein, is damaged by pasteurization to an appreciable degree. . . . No milk is really safe that has not been pasteurized. The best milk is that which comes from a tuberculin-tested herd and which is subsequently pasteurized by the low-temperature process."

Further Observations on the "Digestibility" of Common Foodstuffs as Determined by Radiography. W. C. D. MAILE AND K. J. L. SCOTT. *Lancet*, 228, p. 1500, June 29, 1935.

The "digestibility" of raw whole and skimmed milk, whole and skimmed boiled milk, peptonized, citrated and alkaline milks, and milk with Robinson's patent barley, raw and boiled, has been studied. Of these variously treated milks, boiling alone reduced the time the milk remained in the stomach, from an average period of over three hours to three hours or under. Childrens' stomachs emptied faster than did those of adults.

Sugar taken with water leaves the stomach in considerably less time than does sugar alone, the actual emptying time depending upon the amount of water taken. In children a longer time is required for sugar to leave the stomach than for adults. These observations should be of value in the treatment of acidosis and hypoglycemia.

The emptying times were determined by mixing half an ounce of barium with the different foods studied, followed by frequent X-ray screening.

Electrokinetics in Relation to Dairy Phenomena. G. C. NORTH AND H. H. SOMMER, Dept. of Dairy Industry, Univ. of Wisconsin, Madison, Wisconsin. *JOURNAL OF DAIRY SCIENCE* 18, 1, p. 21, Jan., 1935.

The streaming potential method was adapted to measure the zeta-potential at the fat-serum interface of milk. The central chamber of a special vessel had end-walls of platinum with a pin-hole in each. These platinum walls served to retain the fat and also served as electrodes. With a needle in place, through the pin-holes of the two electrodes, the central chamber of the vessel was filled with fluid milk fat. This was then chilled, and the needle was withdrawn, thereby leaving a capillary opening through the solidified milk fat. The capillary was filled with the milk serum in question and allowed to stand for 15 minutes to allow for adsorption. The diluted serum (1 to 10,000) was then streamed through this capillary under an observed pressure, and the potential difference between the two electrodes was measured with the aid of a Compton electrometer, used as the null point instrument. Conductivity measurements were made under the conditions of the test. The results were expressed as $H.K._s/P$, since the other terms involved in the zeta-poten-

tial calculation by this method were not determined, but were considered essentially constant.

The potential at the fat-milk serum interface is normally negative but its magnitude varies considerably when milks from individual cows were examined. As the pH of the serum is lowered the potential decreases; the isoelectric point was at pH 4.3; at still lower pH the potential was positive. The potential increased markedly as the temperature of measurement was increased. Chlorides of potassium, calcium, iron (ferrie), and thorium lowered the potential, except that the potassium chloride in small concentrations showed a slight increase, but a decrease in higher concentration. Thorium chloride actually made the potential positive. Sodium citrate and di-sodium phosphate increased the negative potential, the citrate being the more effective.

The Action of Milk Fat as a Foam Depressant. ABRAHAM LEVITON AND ALAN LEIGHTON, Bureau of Dairy Industry, U. S. Dept. of Agr., Washington, D. C. *JOURNAL OF DAIRY SCIENCE* 18, 2, p. 105, Feb., 1935.

In the study of the method by which milk fat acts as a foam depressant, the foaming power was measured by uniformly agitating 20 cc. samples in graduated cylinders and measuring the volume of foam one minute after agitation has ceased. Procedures are described for the measurement of dynamic surface tension, and of an index of superficial viscosity.

The destructive action of milk fat on milk serum foam can neither be attributed to changes in the dynamic and static surface tension of the serum, nor to changes in superficial viscosity, nor to changes in the quantity of protein adsorbed at the air/serum interface. The analogy which exists between the existence of a rupture in a thin film, and the presence in it of a spreading substance is offered as an interpretation of the phenomenon observed.

Dietetic Deficiencies and Susceptibility to Infection with Special Reference to Children. H. M. M. MACKAY. *Lancet*, 229, p. 1462, Dec. 29, 1934.

While the spectacular results observed from dietary deficiency in times of extreme famine are not frequently seen, there are widespread and serious conditions arising from partial deficiencies which occur in the poorer sections of many cities. The effect of dietary deficiency on the incidence of disease has been observed by many. The author discusses this relationship, particularly as it applies to susceptibility to respiratory infections in children resulting from lack of vitamin D and iron. It is pointed out that many cases are the result of deficiency in several factors, as shown by the fact that the addition of one missing vitamin or other elements brings about only partial improvement.

However, when milk is added to the diet, a general improvement is observed which does not result when other foods are added, beneficial though they may be up to a certain point.

Gastric Digestion of Raw and Boiled Milk in Infants. J. G. OGILVIE AND O. D. PEDEN. *Lancet*, July 14, p. 76, 1934.

A comparative study of peptic activity in 24 infants receiving raw and boiled milk indicates that there is no significant difference in the gastric digestion of these two forms of milk.

A Study of the Salting of Milk by Determination of the Ratio Phosphorus-chlorine. R. VIVARIO AND C. STAINIER, University of Leige. *Le Lait*; 3, p. 1073, 1933.

The authors find that the method advocated by Mlle. Sarrau is not exact. The variation in the phosphorus content of milk does not follow the change in sodium chloride. A deficiency of lactose leads ordinarily to a diminution in phosphorus. A decrease in the phosphorus is counter balanced by an increase in chlorides. The milk phosphorus is counterbalanced by an increase in chlorides. The milk must be isotonic with blood and therefore when one element decreases some other element must increase. Curves are given showing the change in sodium chlorides and phosphorus throughout a lactation period. As phosphorus decreases sodium chloride increases. Therefore, without a history of the milk absolute detection of added salt is impossible.

The Influence of Fluorine Ingestion upon the Nutritional Qualities of Milk. P. H. PHILLIPS, E. B. HART AND G. BOHSTEDT. Dept. of Chem., Dept. of Animal Husb., Univ. of Wisconsin, Madison. *J. Biol. Chem.* 105: p. 123, 1934.

Small quantities of fluorine in the diet of humans or the feed of animals causes defective teeth formation. To what extent the nutritional value of the milk was affected by different levels of fluorine intake by the animals was the study undertaken. It was found difficult to influence the fluorine content of milk by dietary means and that the storage of fluorine was not proportional to the total fluorine intake. Apparently a mechanism of elimination operates beyond certain threshold limits. Fluorine determination of milk from cows receiving no added fluorine to their rations and from those receiving added sources of fluorine were not widely different with respect to fluorine content, The range of values for the amount of fluorine in normal milk was 0.05–0.25 mg. per litre (Av. 0.138 mg.). From 4.5 to 132 micrograms of fluorine per rat per day produced no detectable toxicosis nor did they produce any physiological stimulation.

Public Control of the Vitamin D Potency of Vitamin D Milk. CLARENCE A. SMITH. Tech. Director, Dry Yeast Dept., Standard Brands, Inc. Milk Dealer, 23, 10, p. 38, July, 1934.

The author points out that the three present methods of producing vitamin D milk all have inherent control features. Few new products have been introduced on the market supported by so large an amount of thorough scientific research as has vitamin D milk.

Irradiated milk is subject to instrumental control which, although not absolute, is usually effective. Milk fortified by the addition of vitamin D concentrate is subject to control of the potency of the concentrate and of the amount added to the milk. The feeding of irradiated yeast to cattle to produce vitamin D milk is controlled through the vitamin D content and the amount of the irradiated yeast. The factors which affect the transfer of potency from the yeast to the milk have been established.

The problems of the control officials are therefore simplified, since the product has already been subjected to scientific control measures. Analysis of milk, however, for vitamin D potency is time consuming and expensive, a single test costing from \$25.00 to \$50.00. Biological tests requiring the use of living animals are necessary. When samples are taken and tests made by control officials, without the prior knowledge of the producer, two or three tests yearly should be sufficient to establish effective control.

Minimum standards of potency must be established. Scientific evidence to date indicates that 55 to 60 Steenbock units per quart is a suitable minimum requirement for vitamin D milk produced by yeast feeding and for irradiated milk. The minimum potency of milk fortified by a concentrate has not been set at present, but the newly adopted USPX unit seems to be the best measurement at present. One Steenbock unit equals 2.7 USPX units.

Try the Milk Treatment for Intestinal Parasites. JAMES A. TOBEY, The Borden Company, New York City. The Milk Dealer, 23, 10, p. 35, July, 1934.

Ascaris lumbricoides is the common round worm which occasionally inhabits the human intestinal tract. The author recommends that people afflicted with this worm, and other parasites, should drink plenty of milk each day.

These parasites are primarily vegetarians, thriving on vegetables and cereals, the high starch content of which provides the best food for them. The factor in foods of animal origin that discomforts these worms is the protein particularly the casein in milk.

Investigations with laboratory animals and actual experience with afflicted persons have demonstrated the beneficial effect of milk in the elimination of the various intestinal parasites.

Zoologists have pointed out that there are 85 different species of worms that may act as parasites in our system, as well as 25 different protozoa, and a few other species. Dogs, cats and other animals are also afflicted with parasites of various types, and they, like humans, benefit from high protein diets, especially those containing plenty of milk.

The Transmission of Vitamin A from Parents to Young in Mammals.

II. The Carotene and Vitamin A Content of Cow's Colostrum.

WILLIAM JOHN DANN, University of Cambridge, England. *Biochem. J.* 27: 6, p. 1998, 1933.

The growth-promoting, anti-infective vitamin—A—is closely related to the yellow pigment (carotene) content. A study of the colostrum and milk from each of 14 cows showed that there may be from 10 to 100 times as much vitamin A in colostrum as in the later milk, independent of the season. The importance of colostrum milk for the calf is demonstrated by the fact that on the first day of life the calf receives supplies of vitamin A greater than the later milk could give in 20 to 50 days.

Feeding Experiments Show Importance of Vitamin A Content of Milk.

O. E. REED, Bureau of Dairy Industry, Washington, D. C. *Certified Milk*, 9, 93, p. 7, 1934.

Experimental work with dairy herds of the Bureau of Dairy Industry shows that cows fed on a ration adequate in every respect except vitamin A, produce milk deficient in this vitamin. The cows on this experiment have never given birth to normal calves. Over 75 per cent of these calves have been born prematurely, although the herd was free from infectious abortion. Over half of them were born dead, others were blind at birth and the rest so weak that they survived only a few days. Milk from these cows fed to normal calves resulted in death of all the calves, usually from pneumonia. Other calves lived when fed the same ration with the addition of cod liver oil or cream as a source of vitamin A. The butter fat from the milk produced by these cows was nearly white and contained only 10 per cent as much yellow color as that from cows fed alfalfa hay.

A Study of the Action of the Proteolytic Enzymes of Specific Organisms upon the Proteins of Milk and upon Gelatine. GEORGE SPITZER, E. H. PARFITT AND W. F. EPPLE, Purdue Univ., Agr. Exp. Sta., Lafayette, Indiana. *Purdue Agr. Exp. Sta. Bull.* No. 385, Sept., 1933.

The object of this study was to determine the proteolytic action of the enzymes of some of the typical types of microorganisms met with in the dairy industry. The proteolytic enzymes of thirty microorganisms and associated types and combinations were studied.

Secretion of Certain Constituents of Milk—Vitamin D. C. N. FREY, R. F. LIGHT, AND L. T. WILSON. *Certified Milk*, 9, 93, p. 6 and 94, p. 10, 1934.

Four cows, two having an average daily production of 25 quarts, and two giving 11.5 quarts per day were milked at 12 hour intervals. These cows were milked 6 hours after the previous milking and again at the regular milking time. The high producing cows secreted 61.5 per cent of the 12 hour production during the first 6 hours, whereas the low producers secreted 54.5 per cent. This is of importance in regulating the time of feeding irradiated yeast to fortify the vitamin D content of cow's milk. Assays were made of the vitamin D content of the blood and milk of a cow fed irradiated yeast. The results showed that 70 per cent of the vitamin D fed the cow was absorbed in the blood stream. This absorption into the blood stream is greatest during the first and second hour after feeding. The rate of disappearance of this vitamin D from the blood is too fast to be accounted for by excretion in the milk or in the feces. The secretion of vitamin D in the milk runs nearly parallel to the level of vitamin D in the blood

MISCELLANEOUS

Immunization Experiments on Calves with BCG. A. STANLEY GRIFFITH, J. BASIL BUXTON AND R. E. GLOVER. *Lancet*, 228, p. 451. Feb. 23, 1935.

Thirteen calves vaccinated intravenously with single doses of BCG at intervals of six, nine and twelve months after the first protective injection were given virulent bovine tubercle bacilli orally to test their resistance. Unimmunized calves were given equal doses of the bovine culture and were studied as controls.

The controls calves, killed 84 to 158 days after being given the test dose, all showed tuberculosis of the glands of the alimentary tract and two showed more generalized tuberculosis.

Of the revaccinated calves eight of the thirteen were free from tuberculosis, four showed encapsulated lesions, and one showed moderate tuberculosis.

The authors conclude that intravenous injections of BCG confer complete immunity to tuberculosis in calves for a variable length of time up to more than a year. Revaccination gave complete immunity in a much smaller number of calves. However, the number of animals studied is too small for definite conclusions.

Experiments on the Purification of Creamery and Packing-House Wastes. MAX LEVINE, Engineering Experiment Station, Iowa State

College, Ames, Iowa. *Amer. Jour. Pub. Health*, 25, 2, p. 171, 1935.

This article deals principally with the purification of packing-house wastes.

On Bacterial Enzymes. W. GRIMMER AND J. RODENKIRCHEN, Dairy Institute, University of Königsberg, Germany. *Milchw. Forsch.* 17, 1-2, p. 65, Feb., 1935.

It was found that, while some bacteria (species of *Micrococcus*, *Sarcina*, spore-forming and non-spore-forming rods studied, a species of *Saccharomyces*, and a species of *Torula*), formed as much or more catalase under anaerobic than under aerobic conditions, there were other bacteria which produced much less or none at all under anaerobiosis.

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JOURNALS

American Creamery and Poultry Produce Review	Journal of Dairy Science
American Journal of Diseases of Children	Journal of Experimental Medicine
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Journal of American Medical Association	Zeitschrift für Physikalische Chemie, Abt. A und B
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SPECIAL PUBLICATIONS

Federal Dairying and Bacteriological Establishment, Liebefeld, Berne, Switzerland	New York Association of Dairy and Milk Inspectors
International Association of Ice Cream Manufacturers	Prussian Dairy Research Institute, Kiel, Germany
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National Dairy Experiment Station, Hillerod, Denmark	United States Department of Agriculture
National Institute for Research in Dairying, Reading, England	

ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

BUTTER

Factors Affecting Economical Manufacture, Uniformity in Composition and Quality of Butter. D. H. NELSON, Dairy Industry Div., Univ. of California, Davis, California. *J. Dairy Sci.* 18, 4, p. 207, April, 1935.

Samples of butter, taken from the churn and representing between 60 per cent and 70 per cent of the butter made in California during 1932, were analyzed by the Kohman Method. The majority of these samples contained between 80 per cent and 81 per cent fat, and between 0.60 per cent and 0.70 per cent "curd by difference." These figures do not agree with "averages" given by five recognized references. They do, however, emphasize the importance, in controlling the overrun, of making a complete analysis instead of assuming that the curd content is 1.0 per cent. They also emphasize that even under commercial conditions, a fat content between 80 per cent and 81 per cent can be easily maintained. The resulting high overrun (23.3 per cent to 24 per cent) is important in the economical manufacture of butter. Maintaining the composition within these narrow limits results in a more uniform quality of butter.

D.H.N.

The Hydrogen-ion Concentration of Creamery Waters and Their Relationship to Washing Butter. N. S. GOLDING, Univ. of Idaho, Agr. Exp. Sta., Moscow, Idaho. *J. Dairy Sci.* 18, 6, p. 359, June, 1935.

The reaction (pH) of a number of creamery water supplies in Idaho and Washington have been made at their respective creameries by colorimetric methods. As a considerable proportion of these waters were found to be alkaline in reaction, one such supply was employed to determine the effect of an alkaline water, when used for washing butter.

The first wash water, after washing the butter, was found to have a reaction between that of the water and cream while the second wash water retained the reaction of the original water. On determining the reaction of the serum of the butter, only slight changes were found; therefore, it was concluded that the changes in the reaction of the second wash water were largely a surface effect on the butter.

The nitrogen (protein) removed from butter in the grain by wash waters at various reactions was determined and found to be slightly greater in the alkaline wash waters as compared with those which had been acidified. After extraneous buttermilk was removed, which affected the reaction of the first wash water, the evidence of dissolved protein in the alkaline wash water was more marked.

The effect of alkaline water on the texture of the butter by possibly liberating more free fat in the butter was anticipated, but further experiments are necessary to establish the theory. N.S.G.

A Method for the Microscopic Examination of Butter. A. C. FAY, Kansas Agr. Exp. Sta., Manhattan, Kansas. *J. Dairy Sci.* 18, 9, p. 603, Sept., 1935.

One-tenth ml. of melted butter, one drop of Mayer's egg-albumin mixture, and one drop of xylol are thoroughly mixed and spread over the entire surface of a 1 × 3-inch glass slide. After heating for 10 to 15 minutes on a hot water bottle at 80° C., the smear is fixed in 70 per cent alcohol, immersed in xylol, air dried, and stained in methylene blue. If the microscopic field is adjusted to a diameter of 0.157 mm., the average number of bacteria per field multiplied by 1,000,000 gives the number per ml. of butter. A.C.F.

The Creatine Test for Acetylmethylcarbinol Plus Diacetyl in Butter Cultures. B. W. HAMMER, Iowa State College, Ames, Iowa. *J. Dairy Sci.* 18, 9, p. 579, Sept., 1935.

The creatine test for acetylmethylcarbinol plus diacetyl in butter cultures is an adaptation of the O'Meara test for detecting the formation of acetylmethylcarbinol by bacteria fermenting carbohydrate. The test makes it possible to quickly secure general information on the comparative amounts of acetylmethylcarbinol plus diacetyl present in various cultures.

B.W.H.

Diacetyl in Cold-stored Butters. D. R. BARNICOAT, Res. Inst. (N. Z.) Dept. of Sci. and Ind. Res., Palmerston North, N. Z. *J. Dairy Res.* 6, 3, p. 397, Sept., 1935.

In four churnings of the common non-starter butter, acetylmethylcarbinol was found to the extent of 0-0.6 p.p.m. when fresh and a trace to 0.4 p.p.m. after 6½ months of storage at 14-17° F. The addition of 2½-4 per cent of starter to split batches of the same cream as used for the above butter samples increased the acetylmethylcarbinol content of the fresh butter to 0.7-2.0 p.p.m. when fresh and 0.8-1.8 p.p.m. after 6½ months of storage. The diacetyl content was not determined in these butter samples when fresh, but was found to be zero in the non-starter butter after three and six months and 0.4-4 p.p.m. in starter butter after three months and 0-0.2 p.p.m. in the butter after 6½ months of storage at 14-17° F. Thus there appeared to be little change in the natural carbinol plus diacetyl content of butter during storage.

The author concluded that most of the acetylmethylcarbinol plus

diacetyl found in the butter from slightly ripened cream was not developed during the ripening process but was added preformed in the starter. He points out that apparently the final concentration of carbinol plus diacetyl in butter is dependent upon the amount of buttermilk retained and these substances are held in the aqueous portion, possibly adsorbed on the protein, rather than dissolved in the fat.

When diacetyl in the amount of 4 p.p.m. (1 per cent of a 400 p.p.m. solution made from Polak's 50 per cent diacetyl) was added to either "non-starter" or "starter" butter, considerable losses of diacetyl occurred during storage. The extent of the losses of diacetyl is about the same (40 per cent) for the "non-starter" and "starter" butter, but in the "starter" butter, part of the diacetyl has merely been reduced to its precursor (carbinol) form by the action of the lactic streptococci. It is inferred that from the point of view of aroma alone the "starter" butter will maintain a better flavor during storage than "non-starter" butter.

The loss of diacetyl in "non-starter" butter and to a lesser extent in the "starter" butter is considered to be due to oxidation to acetic acid by incorporated air.

H.A.B.

Preparing Butter Samples for Analysis. D. H. NELSON, Univ. of California, Davis, California. *J. Dairy Sci.* 18, 10, p. 667, Oct., 1935.

A modification of the horizontal spiral bit type of mechanical mixer is described for preparing samples of butter for analysis. This modification has been designed to overcome the more serious disadvantages of mechanical mixers used for this purpose. The following conclusions are drawn from the data presented: (1) Any temperature between 12° C. and 24° C. may be used, (2) partial separation of the sample, caused by melting around the edges, seriously interferes with the proper preparation of the sample, and (3) the sample must be mixed for at least 3 full minutes.

D.H.N.

Factors Affecting Milk and Butterfat Secretion. I. Variations in Fat Weight, Fat Percentage, and the Amount of Fat in the Milk Required to Make a Given Weight of Butter. ELIZABETH O. WHETHAM AND JOHN HAMMOND, School of Agriculture, Cambridge, England. *J. Dairy Res.* 6, 3, p. 320, Sept., 1935.

Dairy show records were examined for the ratio of the weight of fat in the milk required to make a pound of butter. This ratio was taken to indicate the size of the fat globule in the milk. From such considerations the authors believe to have found support for the theory that the size of the fat globule is in some degree conditioned by the rate of milk secretion, an increased rate resulting in smaller globules. The size of the globules is

smaller because they are washed out from the cell at a greater rate of speed. Furthermore the size of the fat globule is held to be influenced by the rate of butterfat formation by the cell, which varies with breed and stage of lactation.

H.A.B.

Committee Comments: The method used by the authors for churning and calculating the fat weight: butter weight ratios is not clear. All ratios of fat weight: butter weight given are greater than 1 and the authors state, "It requires, at the one extreme with Friesian milk, 1.260 lb. of fat to make 1 lb. of butter, and at the other extreme with Jersey milk 1.011 lb. of fat to make 1 lb. of butter." How the fat weight: butter weight ratios can be higher than one is not clear as the weight of butter should exceed the weight of fat.

Factors Affecting Milk and Butterfat Secretion. II. The Colour of the Butterfat. ELIZABETH O. WHETHAM AND JOHN HAMMOND, School of Agriculture, Cambridge, England. J. Dairy Res. 6, 3, p. 340, Sept., 1935.

The colors of the butter for individual cows at the London Dairy Show were measured on a color scale made by spraying the colors on celluloid strips and coating them with cellulose. The mean values and variability curves of the ranges of butter color in the different breeds of dairy cattle are given. The breeds studied ranked as follows in the intensity of the butter color: South Devon, Guernsey, Jersey, North Devon, Friesian, Shorthorn, Ayrshire, Dexter, Red Poll, Kerry. From 25 to 263 cows in each of these breeds were studied and the feeds of the cows were not the same.

A slight increase in the shade of color was found to occur under most of the various conditions which give rise to increased milk yield, which may be due to the greater amount of coloring matter in proportion to butterfat produced. Milking three times a day caused a slightly darker yellow butter than twice daily milking, especially in the case of Shorthorns and Ayrshires. The difference was not significant for Friesians and Jerseys.

Age had little influence on the butter color although the tendency seemed to be toward a slightly darker color as age increases. The advance of the lactation period also showed no very distinct effect on the butter color within the individual breeds in this study, although the average of all breeds indicated a slight drop in color intensity during the first 120 days of the lactation period when more fat is required from the body in addition to that from the food. After 150 days the color gradually rises again as the butter yield falls and more of the fat is supplied by the food intake. It is suggested that butterfat derived from body fat will be paler than that from food fat, when the latter is sufficiently provided with plant pigments, because when fat is withdrawn from the body cells, the pigment is partially retained and becomes concentrated in them.

H.A.B.

Sanitary Conditions in Creameries Improved, Says Food Official. J. O. CLARKE, Food and Drug Administration, U. S. Dept. of Agriculture. Dairy Produce 41, 10, p. 9, October, 1935.

This is a summary of the work of the Food and Drug Administration of the United States Department of Agriculture in the cream quality improvement campaign. Data are given showing the number of cans of cream and pounds of butter examined and the percentage of condemnation. In the summer and fall of 1934, 3.51 per cent of all cream examined was condemned. In the period from January to July, 1935, 4.35 per cent was condemned, while in the period from July to September, 1935, only 2.70 per cent was condemned. Of the cream condemned 41.8 per cent was condemned as cheesy, 23.1 per cent as moldy, 20.8 per cent as putrid, 8.2 per cent as yeasty, 3.4 per cent as rancid, and 2.7 per cent because of extraneous matters. S.T.C.

The Effect of Soybeans in the Rations of Dairy Cows upon the Vitamin A Value of Butter. J. W. WILBUR, J. H. HILTON, AND S. M. HAUGE, Dept. Dairy Husb., Purdue University, Lafayette, Indiana. J. Dairy Sci. 18, 10, p. 661, Oct., 1935.

Soybeans in the rations of dairy cows suppress the transference of the vitamin A activity of the ration to the butterfat. Dairy cows which received constant levels of vitamin A throughout the successive periods, produced butter of lower vitamin A value when soybeans were fed in the grain ration than when linseed oil meal was used. The attempt to correct this suppressing action by roasting the soybeans used in the grain ration was unsuccessful. J.W.W.

CHEESE

The Bacteriology of Swiss Cheese. II. Bacteriology of Swiss Cheese in the Press. W. C. FRAZIER, L. A. BURKE, A. J. BOYER, AND G. P. SANDERS, U. S. Dept. of Agric., Washington, D. C. J. Dairy Sci. 18, 6, p. 373, June, 1935.

Bacterial activity in Swiss cheese from the time the curd is dipped from the kettle until 21 hours later was controlled largely by the temperature of the cheese. The temperature at dipping (50.0–51.0° C.) prevents the increase in numbers of bacteria for several hours although the pH was found to decrease rapidly. This increase in acid without apparent growth of bacteria was explained by the fact that the cells were many times larger in volume and therefore capable of comparatively greater activity per cell; moreover, small amounts of acid produce relatively large changes in pH due to the relatively low buffer value of the cheese mass when the pH is high. *Streptococcus thermophilus* (C₂) increased in numbers within

3 or 4 hours after dipping, grew rapidly until the 6th or 8th hour, and was chiefly responsible for the production of acid during this 6-hour period. The lactobacilli organisms did not start growth until the cheese had cooled below 44° C. *Lactobacillus bulgaricus* (Ga) showed growth after the 5th hour and *Lactobacillus helveticus* (39a) not until after the 10th hour. Bacterial activity and acid production from the 8th to 21st hour was attributed largely to the lactobacilli. *S. lactis* died off rapidly in the press. *Escherichia communior* and *Aerobacter aerogenes* grow in the press and may cause gassiness or "bloat"; active starters of *S. thermophilus* and lactobacilli effectively inhibit them. The presence of large numbers of *A. aerogenes*, even though inactive in the press, resulted in poor quality cheese. *Propionibacterium shermanii* do not grow but usually decrease in numbers in the press. *L. lactis* and *L. longus* types were able to grow rapidly, but usually were not present in large numbers. These studies were with cheese of 55 pound weight but comparisons were made with factory cheese. The lactobacilli start growth several hours later in factory cheese due to the slower cooling in the larger cheese. Bacterial determinations were made by microscopic counts supplemented by a special staining technique showing living cells.

L.A.B.

The Bacteriology of Swiss Cheese. III. The Relation of Acidity of Starters and of pH of the Interior of Swiss Cheeses to Quality of Cheeses. W. C. FRAZIER, W. T. JOHNSON, JR., F. R. EVANS, AND G. A. RAMSDELL, Res. Laboratories, Bureau of Dairy Ind., Washington, D. C., and Grove City, Pa. *J. Dairy Sci.* 18, 8, p. 503, Aug., 1935.

A study of Swiss cheese manufactured under factory conditions has indicated that a good quality of cheese is likely to result when a *Lactobacillus helveticus* milk starter with an acidity of 1.0 to 1.09 per cent after growth for 12 hours at 37.5–39° C. is used together with a 12-hour, 37° C. milk starter of *Streptococcus thermophilus* with a titratable acidity of 0.7 to 0.75 per cent or a whey starter with an acidity of 0.30 to 0.33 per cent. The pH of the interior of the cheese in the press, which is indicative of the activity of the starter organisms, should be about 6.0 to 6.09 after three hours in cheese made from milk with a pH of 6.5 to 6.6 and should be less than 5.2 after 21 hours in the press; preferably the pH should be between 5.15 and 5.0.

W.C.F.

The Preparation of Mold Powder for Blue-veined Cheeses. R. V. HUSONG AND B. W. HAMMER, Iowa State College, Ames, Iowa. *J. Dairy Sci.* 18, 9, p. 599, Sept., 1935.

The method consists of growing the desired mold on bread under aseptic conditions, drying, and grinding to a fine powder. The advantages of

the method are (a) high yield of powder containing a large number of mold spores per gram, (b) relatively short time required for the preparation of the powder and (c) freedom of the powder from contaminating molds.

R.V.H.

The Function of Pepsin and Rennet in the Ripening of Cheddar Cheese.

I. R. SHERWOOD, Dairy Res. Inst. (N. Z.), Palmerston North, New Zealand. *J. Dairy Res.* 6, 3, p. 307, Sept., 1935.

The purpose of this investigation was to obtain confirmatory evidence for the contention developed in a previous work that the breakdown of cheese protein during ripening of the cheese is due almost entirely to the proteolytic enzymes of the rennet retained in the cheese.

In a preliminary experiment, raw skimmilk to which 2 per cent chloroform had been added was used as a substrate and it was found that an increased concentration of rennet as well as pepsin leads to a more complete protein breakdown in the milk. A 6.25 per cent solution of pepsin, however, had only about $\frac{1}{3}$ as great proteolytic power as the rennet solution used.

In the first regular experiment cheese was made from milk flash heated to 155° F. and coagulated with rennet, with pepsin and rennet, and pepsin and the type and extent of protein breakdown during the ripening of the cheese was observed. The pH values of the resulting cheeses in the green state were nearly the same and there were no marked differences in the bacterial counts of the cheese during the ripening period. The extent of the protein breakdown in the cheeses made with pepsin was much smaller than that made with the rennet, and when a mixture of pepsin and rennet was used the extent of the protein breakdown was intermediate.

In another experiment the doubling of the amount of rennet used from four ounces per 1000 pounds of milk to eight ounces caused a considerable increase in the degree of protein decomposition. The type of nitrogen breakdown was similar in all batches in both experiments.

A "pepsin" solution prepared by heating rennet to 70° C. for two minutes at a pH of 5 in order to destroy the rennin exhibited a coagulating power which was only $\frac{1}{2}$ to $\frac{1}{3}$ that of the unheated rennet. When 5 per cent solutions of commercial pepsin were heated in this manner, their coagulating power was only 5 per cent of the original.

A "rennin" solution prepared by heating rennet to 38° C. for 10 minutes at a pH of 7.25 to destroy the pepsin had a clotting power which was not markedly reduced although at times it was reduced to $\frac{1}{2}$. When prepared in the same manner, from 5 per cent solutions of commercial pepsin, its clotting power was only $\frac{1}{50}$ that of the original pepsin solution.

The above heat treatments on either rennet or commercial pepsin solu-

tions had only very little influence upon the proteolytic activity of the coagulations. It is concluded that the heat treatments mentioned are not effective in destroying rennin and pepsin and that the proteolytic activity and coagulating action are due to separate enzymes. It is also suggested that a rough guide to the comparative protein breakdown that will occur in cheese is given by measurement of the degradation brought about in milk by the respective coagulating enzymes employed. H.A.B.

CONCENTRATED AND DRY MILKS

The Heat Stability of Evaporated Milk Made from Hard-curd Milk, Soft-curd Milk and Milk from Mastitis Infected Udders. R. C. WELCH AND F. J. DOAN, Div. of Dairy Manuf., The Penn. State College, State College, Pa. *J. Dairy Sci.* 18, 5, p. 287, May, 1935.

There is apparently no difference in the stability toward heat between hard-curd milk and soft-curd milk after condensation under uniform conditions. Concentrated milk from animals afflicted with subclinical mastitis in one or more quarters of the udder, however, is decidedly less stable than normal milk. It furthermore reacts oppositely toward factors affecting stability, being stabilized by agents which destabilize normal milk and vice versa. This is probably a reflection of the altered mineral composition of mastitis milk. F.G.D.

ICE CREAM

The Storage of Packed Ice Cream. RICHARD W. SMITH, JR., Dairy Dept., Vt. Agr. Exp. Sta., Burlington. *Vt. Agr. Exp. Sta. Bul.* 394, June, 1935.

The storage of packaged ice cream was studied with respect to its effect upon flavors, shrinkage and surface condition.

The batches of vanilla, chocolate, strawberry and maple walnut ice creams were made, five in the University dairy laboratory and five in a commercial plant.

In general, 13 quarts and 13 pints of each flavor were withdrawn from storage the day after each batch was frozen, marked, carefully weighed and replaced in storage. A pint and quart package of each flavor was withdrawn weekly for about seven weeks and thereafter fortnightly until supply was exhausted. At these times they were reweighed and critically examined for flavor, texture and body. It was concluded that:

Vanilla, strawberry, chocolate and maple walnut ice creams stored at hardening room temperatures of from -6° F. to -20° F. do not materially change in weight over periods of from 16 to 24 weeks, nor do they shrink appreciably in volume.

Unlined packages of vanilla and strawberry ice creams developed sur-

face film in from 107 to 114 days, maple ice cream sometimes filmed slightly in about the same time, whereas chocolate goods developed no film. No film formed in lined packages.

In general, the body and texture of packaged ice cream did not deteriorate with age. Chocolate and maple walnut ice creams kept well and retained their desirable flavors over periods of three to four months. Vanilla may develop "off-flavors" in about 100 days. Strawberry is more likely to develop flavor trouble during storage than the other three and should be held for not more than two and preferably not more than one month.

It was pointed out that manufacturers may avoid excessive peak loads by storing chocolate and maple walnut ice creams, and possibly small amounts of vanilla, several weeks ahead of the rush period, thus freeing equipment for use in making ice creams and sherbets that do not keep as well. It was also pointed out that the initial quality of the ice cream must be good or successful storage is impossible. J.M.F.

Committee Comments: It is well known that the quality of the ingredients used in ice cream affects its keeping quality and that ice cream never improves with age. Hence, the period of time between manufacture and consumption should be as short as possible.

A Study of Factors Influencing the Separation of Whey in Ice Cream Mixes Containing Vegetable Stabilizers. I. A. GOULD AND P. S. LUCAS, Michigan State College, East Lansing, Michigan. *J. Dairy Sci.* 18, 5, p. 307, May, 1935.

Ice cream mixes containing 0.4 per cent of a gum containing stabilizer known to cause whey separation were subjected to various temperature treatments. Pasteurization of the mixes before and after adding the stabilizer demonstrated that the agent causing the difficulty is heat labile and is principally found in, or due to, the milk products of the mix rather than the stabilizer. Pasteurization of the milk products of the mix at 145° F., 165° F., and 175° F. for 30 minutes before adding the stabilizer gave an average whey separation after 96 hours of 41 per cent, 22 per cent, and 10 per cent respectively. Heating the milk products to 205° F. for 1 hour practically eliminated the difficulty, while the heating of a solution of the stabilizer to the same temperature for 2 hours brought a reduction in the whey separation of approximately only 50 per cent. Excessive drying of the stabilizer or variations in the fat and serum solids of the mix had little or no influence on the separation of the whey. P.S.L.

Some Physical Effects of Freezing upon Milk and Cream. B. H. WEBB AND S. A. HALL, Bureau of Dairy Industry, U. S. Dept. of Agr., Washington, D. C. *J. Dairy Sci.* 18, 5, p. 275, May, 1935.

Slow freezing of milk or cream caused a gradual precipitation of the caseinate system and an immediate destruction of the fat emulsion. Freez-

ing did not alter the heat stability of skim milk until the product had been held frozen for several months at -18° C. (0° F.) or below. Freezing caused an immediate increase in the amount of casein which could be centrifuged from milks heated before freezing. Freezing, therefore, caused a slow and gradual increase in the size of the casein aggregates but the change was not noticeable until the freezing period was well advanced. The destruction of the fat emulsion in cream during slow freezing was lessened by adding cane sugar or increasing the solids-not-fat content of the cream before freezing. Homogenization slightly retarded fat separation when low fat creams were frozen. Freezing destroyed the fat clumps formed in cream by homogenization and restored to the cream the heat stability which it possessed before processing. Fresh whole milk was pasteurized, condensed to $\frac{1}{3}$ its weight, canned and frozen without any detrimental effects to the body or flavor of the product. This milk when held frozen at a low temperature and reconstituted at any time within a four-week period by the addition of cold water, yielded a product which often could not be distinguished from fresh market milk. Its use where fresh market milk is expensive or not available was suggested. A process for the preparation of large quantities of normal undenatured casein and of milk serum was developed. Frozen homogenized cream was thawed at a temperature below the melting point of the fat; clear milk serum was collected from the melting mass and the residual mixture of fat and casein was utilized in the preparation of normal casein or to raise the protein solids of ice cream mix.

B.H.W.

Observations on the Freezing of Milk and Cream. F. B. BALDWIN, JR., AND F. J. DOAN, Penn. Agr. Exp. Station, State College, Pa. *J. Dairy Sci.* 18, 10, p. 629, Oct., 1935.

The variations in the percentage of fat in the frozen and unfrozen portions of milk, partially frozen without agitation, were found to be due to the creaming phenomenon.

Cream containing over 25 per cent of fat was found to freeze homogeneously, the frozen and unfrozen portions having the same concentration of colloidal and soluble substance throughout the entire range of freezing to apparent solidity.

It was concluded that increasing amounts of fat interfered physically with the diffusion and concentration of the constituents into the unfrozen portions of unagitated, freezing cream.

F.B.B.

MILK

Oxidized Flavor in Milk. I. The Probable Relation of Lecithin to Oxidized Flavor. L. M. THURSTON, W. CARSON BROWN, AND R. B. DUST-

MAN, West Va. Agr. Exp. Sta., Morgantown, West Va. J. Dairy Sci. 18, 5, p. 301, May, 1935.

Butterfat from milk of oxidized flavor, when washed free of substances adsorbed on the fat globules and redispersed in skimmilk of good flavor, gave no trace of oxidized flavor to the resulting reconstituted milk. Subjection of the reconstituted milk to the treatment by which oxidized flavor had been developed in the normal whole milk failed to cause the development of oxidized flavor in the reconstituted milk. That oxidized flavor in milk differs from the flavor caused by oxidized butterfat was indicated when purified oxidized butterfat redispersed in skimmilk of good flavor yielded a tallowy flavor which was distinctly different from the so-called oxidized flavor. These results indicate that oxidized flavor in milk develops first in some substance adsorbed on the fat globules and the authors offer evidence that this substance probably is lecithin. L.M.T.

Flavors of Milk and Their Control. C. L. ROADHOUSE AND J. L. HENDERSON, Univ. Farm, Davis, Calif. Univ. of Calif. Bull. 595, 1935.

For several years flavor studies have been continued by the authors and in this publication the available information is well summarized. The authors adhere to the usual distinction between taste and flavor; namely that taste is the impression perceived when the milk is taken into the mouth while flavor is a combination of taste and smell observed when the milk is in the mouth.

In studying the variations in the taste of milk produced by different cows, the feed was withheld for 5 hours before milking. This study shows that a low chloride-lactose number (per cent chloride/per cent lactose $\times 100$) is usually associated with a desirable primary taste, also that 12.68 per cent of the 536 cows in 12 herds produced milk having abnormal taste or flavor.

The study of feed flavors was divided in two parts: (1) those due to roughage, and (2) those due to concentrates. Musty hay, corn silage, green barley, green wild oats, green foxtail, green filaree, alfalfa hay, green alfalfa, clover hay, and clover pasture impart a feed flavor the intensity of which increases both as the amount of feed consumed increases and as the interval of time between feeding and milking becomes shorter. Even 5 pounds of alfalfa hay, 10 pounds of green alfalfa, or 10 pounds of corn silage produced a distinct and undesirable flavor when fed one or two hours before milking. Tame oat hay when fed two hours before milking imparts a "slight after-flavor" if 8 or 9 pounds are consumed but has no detrimental effect when only 5 pounds are fed. Feeding tame oat hay together with any roughage which does impart a feed flavor to the milk does not modify the intensity of the flavor. When natural green feed is fed, the flavor is most prominent in milk drawn approximately one or two hours

afterward. In no case did the milk with feed flavors score below 20 points for flavor.

The usual concentrate feeds—rolled barley, cocoanut meal, soybean meal, cottonseed meal, wheat bran, and dried beet pulp—when fed one to two hours before milking, in quantities used by the average commercial dairyman, did not give milk sufficient flavor to make it undesirable to the average consumer. Wheat bran seemed to improve the flavor of the milk when fed in $5\frac{1}{2}$ to 7-pound quantities one hour before milking.

Three abnormal conditions of the cow were reported that affect the taste and flavor of the milk. Salty taste was observed in milk from certain cows which were advanced in lactation and also from one or more quarters of udders previously affected with mastitis. Saltiness resulting from mastitis is more easily detected from the physical condition of the udder and usually also from the appearance of the milk itself. Usually one cannot recognize salty taste in mixed milk produced by several cows because of the dilution of abnormal with normal milk. Rancid milk was produced by certain cows which had been milking longer than the usual lactation period. Occasionally such milk appears in the first months of lactation. The cause of rancidity that quickly develops in certain milks is the enzyme lipase present in them at the time they are drawn from the cow, but the conditions controlling the presence of lipase in the milk are not known. Pasteurization of milk within a few hours after milking will destroy the activity of the lipase and prevent the development of rancidity.

Oxidized flavor develops in milk that has been in contact with certain corrodable metals. Copper and its alloys have been found to be the most common cause of oxidized flavors. Exposure to sunlight also causes an oxidized or tallowy flavor. The use of non-corrodable metals and the protection of milk from strong sunlight during processing and delivery will eliminate the cause of these defects.

D.H.N.

The Germicidal Efficiency of Lye and Chlorine Solutions for the Sterilization of Milking Machines and Cream Separators. A. C. FAY, W. J. CAULFIELD, AND W. H. RIDDELL, Kansas Agr. Exp. Station, Manhattan, Kansas. *J. Dairy Sci.* 18, 4, p. 239, April, 1935.

Milking machine tubing and teat cups may be effectively sterilized either with chlorine solutions testing 100 parts per million available chlorine or with 0.3 lye solutions, if the solution rack method is used. When the milking machine parts are immersed in crocks containing these solutions, the chlorine disinfectants are less satisfactory.

Chlorine solutions proved to be more effective than lye when used as a disinfectant rinse for cream separators. The results indicate that chlorine solutions used for this purpose should contain at least 200 parts per million

available chlorine in order to insure effective sterilization. Little difference was noted in the germicidal efficiencies of lye solutions containing 1.00, 0.75, and 0.50 per cent sodium hydroxide. Since exposure of separator discs to a 0.5 per cent lye solution tends eventually to corrode the surfaces, the use of lye for sterilizing cream separators is not recommended.

A.C.F.

The Detection of Formaldehyde in Milk by Means of the Methylene Blue Reduction Test. A. C. FAY, Kansas Agr. Exp. Sta., Manhattan, Kansas. *J. Dairy Sci.* 18, 5, p. 327, May, 1935.

It is possible to use the methylene blue reduction test as a basis for suspecting the presence of formaldehyde in milk. The addition of effective quantities of formaldehyde shortens the reduction time, especially if the methylene blue reduction test is run soon after the formaldehyde has been added. Specifically any sample of fresh milk which shows a reduction time of less than one hour may be suspected of containing formaldehyde, and should be subjected to more exact qualitative test.

The range of dilutions of formaldehyde which effectively retarded bacterial growth, definitely delayed coagulation time, and at the same time escaped detection by a majority of those who tasted the milk was between 1:15,000, and 1:25,000. This narrow zone suggests that the addition of formaldehyde to milk by the dairyman is more likely to fail than to accomplish the results desired.

A.C.F.

The Effect of Mastitis upon Milk Production. A. O. SHAW AND A. L. BEAM, Dairy Dept., The Penn. State College, State College, Pa. *J. Dairy Sci.* 18, 6, p. 353, June, 1935.

Mastitis infection was found to reduce milk production approximately 22 per cent and butterfat production approximately 24 per cent after allowance was made for the maximum variation found in the milk and butterfat production of non-infected quarters.

A.O.S.

Biological Methods for the Analysis of Dairy Products. P. A. DOWNS, B. W. HAMMER, W. A. CORDES, AND H. MACY. *J. Dairy Sci.* 18, 10, p. 647, Oct., 1935.

Methods are given for the bacteriological analysis of condensed and evaporated milk. Tests for sterility and the determination of anaerobic, thermophilic, and spore-forming bacteria in evaporated milk, hemolytic streptococci, thermophilic, and gas-forming bacteria causing thickening and gas-forming yeasts, and the yeast and mold content of condensed milk are outlined. Special media for some of these purposes are described. H.M.

A Comparison of Methods of Detecting Streptococci in Freshly Drawn Milk Samples. WAYNE E. PLASTRIDGE, E. O. ANDERSON, AND FRANCIS J. WEIRETHER, Storrs Agr. Exp. Sta., Storrs, Connecticut. *J. Dairy Sci.* 18, 9, p. 583, Sept., 1935.

The relative efficiency of six methods used for the detection of the causative organism of chronic streptococcal bovine mastitis, was determined on 360 individual quarter milk samples. Seventy-nine or 21.9 per cent of the milk samples showed laboratory evidence of mastitis and the presence of streptococci by one or more tests. The incidence of positive findings given by the six methods varied from 3.8 to 98.7 per cent. Microscopic examination of films prepared from incubated milk revealed the presence of the causative organism in a larger number of instances than (1) direct microscopic examination of films prepared from whole milk or sediment, and (2) blood agar plates inoculated with a 4 mm. loopful of whole milk, or a 4 mm. loopful of sediment, or 1 cc. of a 1 to 10 dilution of the sample.

E.O.A.

The Advantages of Skim-milk Agar for the Determination of the Sanitary Quality of Market Milk. C. E. SAFFORD AND C. N. STARK. *J. Dairy Sci.* 18, 8, p. 539, Aug., 1936.

The fermentable carbohydrates and other milk constituents in skim-milk agar make it a desirable medium to use in the routine control of market milk and other dairy products.

The skim-milk agar counts on 618 samples of pasteurized milk were, on the average, two to four times as large as the corresponding counts on standard agar. The counts on 137 samples of raw milk were only slightly higher. The colonies were much larger and consequently could be counted with greater ease and rapidity. The slight opacity of the medium prevents the glare often experienced when artificial lighting devices are used. Acid-producing and protein-digesting types of bacteria can be differentiated on this medium. It supports the growth of bacteria responsible for mastitis in cows. It is simple and easy to make and no more expensive than the present standard agar.

G.E.S.

An Unnoted Hemolytic Streptococcus Associated with Milk Products. J. M. SHERMAN AND H. N. WING, Cornell University, Ithaca, N. Y. *J. Dairy Sci.* 18, 10, p. 657, Oct., 1935.

A hemolytic streptococcus which is believed to represent a new species is described. This organism differs from the pathogenic species of hemolytic streptococci in its higher maximum temperature of growth, a lower minimum temperature of growth, a higher thermal death point, and a more

acid limiting pH of growth. It also differs from the human types in the hydrolysis of sodium hippurate and its failure to ferment sucrose.

Streptococcus hemothermophilus (n. sp.) is suggested as a name.

G.M.S.

The Types of Coliform Bacteria in Bovine Faeces. J. F. MALCOLM, Bact. Dept., the West of Scotland Agric. College, Glasgow. J. Dairy Res. 6, 3, p. 383, Sept., 1935.

In an examination of the coliform flora of 114 specimens of faeces from cows confined to byres during the winter and from cows on pasture, a total of 342 cultures of coliform bacteria were isolated by the ordinary methods. Of these, 96.4 per cent, or 330, cultures were typical *B. coli* and only 3.5 per cent, or 12, cultures were of *Bact. aerogenes*, *Bact. cloacae* and other Koser-positive types. Of the 330 *B. coli* cultures, 211 were obtained from the winter faeces and 119 from the summer faeces. All 12 of aerogenes-cloacae types were found in the winter faeces and none in the summer faeces.

When 100 further specimens were studied by using various enrichment methods, 253 cultures of *Bact. aerogenes*, *Bact. cloacae* and other Koser-positive types of coliform bacteria were isolated from 95 of the specimens. Of the 253 cultures, 125 came from winter faeces and 128 from summer faeces.

It was concluded that although aerogenes-cloacae types may be the most prevalent coliform organisms in soil, on fodder, and on grains, they are also normal inhabitants of the intestines.

A classification of the coliform group of organisms based on the inositol, Koser nitrate, indole, and Voges-Proskauer reactions is suggested.

H.A.B.

Biennial Reviews of the Progress of Dairy Science. Section B. Bacteriology and Mycology Applied to Dairying. A. T. R. MATTICK, E. R. HISCOX, J. G. DAVIS, National Inst. for Res. in Dairying, Univ. of Reading, England. J. Dairy Res. 6, 3, p. 422, Sept., 1935.

This bacteriological review covers technique, sanitary milk production, pasteurization, bacteria, cheese, and butter.

H.A.B.

Mastitis Streptococci in Bulk Milk. E. J. PULLINGER, Res. Inst. in Animal Pathology, Royal Veterinary College, London. J. Dairy Res. 6, 3, p. 369, Sept., 1935.

The main object of this investigation was to see whether it is possible to set up a standard for the amount of contamination of raw milk with the streptococci ordinarily causing bovine mastitis which might be reasonably

permitted by pasteurizing plants from the standpoint of the effect of such contamination on the chemical composition of the milk. It was found that such a standard could not be provided because the number of beta-haemolytic streptococci in milk excreted from day to day by individual cows varied too much. The extent of mastitis in a herd may only be estimated by cultural examination of representative samples four to five times at weekly intervals. The counts for beta-haemolytic streptococci per milliliter were five to ten times higher in the gravity cream than in the whole milk. Microscopical examination of gravity cream or of centrifuge deposit for streptococci or leucocytes may give information not obtainable by cultural methods but does not serve as a substitute for cultural examination.

The extent of contamination of graded and non-graded milk with mastitis streptococci confirms a high incidence of chronic streptococcus mastitis. The ideal to be aimed at is the complete eradication of mastitis by suitable control measures and that such a state can be achieved was demonstrated by the persistent freedom from haemolytic streptococci of the milk of two herds.

H.A.B.

The Pen Barn and Separate Milking Room. H. F. MCCOLLY AND J. R. DICE, N. D. Agric. College, Fargo, N. D. N. D. Agr. Exp. Sta. Bul. 283, Nov., 1935.

This is a bulletin dealing with the adaptability of the pen type dairy barn and separate milking room for the dairy farm, the relative construction and labor cost and practicability as compared to the standard type barn. Plans of construction of various types of pen barns are illustrated and discussed in detail.

C.J.

Experiments with the Methylene Blue Reduction Test for the Grading of Sweet Cream. H. MACY, Div. of Dairy Husb., Minn. Agr. Exp. Sta., St. Paul, Minn. Minn. Agr. Exp. Sta. Bul. 310, October, 1934.

Methods for making the test and results secured in the use of the methylene blue reduction test for the grading of sweet cream are described. The procedure suggested is similar to that recommended for milk in the Standard Methods of Milk Analysis except that a triple strength methylene blue solution is used. Data are given on the reduction time, percentage of butterfat and acidity, direct microscopic count, standard plate counts at 37° C. (98.6° F.) and two days' incubation, and plate counts at 20° C. (68° F.) and five days' incubation for 159 samples of cream. Observations on the use of the test under practical conditions in three creameries are given. A limited number of data are presented comparing the keeping quality of butter made from better quality sweet cream and that from inferior cream.

The author concludes that the methylene blue reduction time is a satisfactory index of the bacterial content of sweet cream and expedient for use in creameries for the grading of cream. The time required for the reduction of methylene blue was inversely proportional to the bacterial content of the cream. The reduction time of samples of cream showing less than 0.21 per cent acidity showed no direct relationship to the acidity of the cream. The reduction time was not significantly influenced by the percentage of fat in the cream. Butter, unsalted and salted, made from the better quality of cream possessed somewhat better keeping quality than the butter from inferior cream.

The test is recommended as a convenient aid in a program directed toward the improvement in quality of sweet cream. S.T.C.

Effect of Heating Milk on the Time which the Curds Remain in the Abomasum of Calves. F. M. MORTENSEN, D. L. ESPE, AND C. Y. CANNON, Iowa State College, Ames, Iowa. *J. Dairy Sci.* 18, 4, p. 229, April, 1935.

Measurements were made on the rate at which the coagula of differently treated milks disappeared from the abomasum of a young calf when the milk was introduced directly into the abomasum by means of a tube through a gastric fistula.

Two liters of raw skim milk left the abomasum in 12 to 18 hours. The evacuation time of the same quantity of boiled milk was usually 8 to 12 hours. Milk autoclaved at 242° F. passed through the stomach at about the same rate as boiled milk. Raw milk coagulates in the stomach of the calf in from 1 to 10 minutes; boiled and autoclaved milk require 8 to 15 minutes. Measurements of the total acid, free acid and hydrogen-ion concentration of the gastric contents indicate that the acidity of the gastric juice does not vary materially when raw or heated milk is fed. Heated milk leaves the stomach more rapidly than raw milk because heat lowers the curd tension and thus permits the curd to break up more easily.

F.N.M.

Relation of the Proteolytic Enzyme Activity of the Proteolytic Organisms Found in Separator Slime. GEORGE SPITZER AND E. H. PARFITT, Purdue Univ. Agr. Exp. Sta., Lafayette, Indiana. *J. Dairy Sci.* 18, 4, p. 267, April, 1935.

A close relation was found between slime and the numbers of proteolytic bacteria contained in the slime. Temperatures usually used in the pasteurization of dairy products (145° F. for 30 minutes and 160° F. for 10 minutes) destroyed approximately 70 per cent of the enzyme action. The experiment was carried out for 14 consecutive months. E.H.P.

Seasonal Variations in the Lipase Content of Milk. J. L. HILEMAN AND ELEANOR COURTNEY, Dairymen's League Co-op. Assoc., Inc., Syracuse, N. Y. *J. Dairy Sci.* 18, 4, p. 247, April, 1935.

The relative amount of lipase present in raw milk was determined by concentrating the fat into a small volume of cream (40 per cent fat) by centrifugal separation, holding this cream under conditions which would allow the lipase to act on the fat while inhibiting the growth of bacteria, and following lipolytic activity by titration of the liberated fatty acids with standard alkali. There is some lipase present in raw milk throughout the year, but the amount varies greatly, the minimum occurring in early summer (June or July) and the maximum in early winter (December or January). The increase in amount of lipase is associated with the late lactation. In commercial practice lipase may produce high titratable acidity and rancid flavor in raw cream during storage at 35 to 40° F. J.L.H.

The Determination of Curd Tension by the Use of Hydrochloric Acid-pepsin Coagulant. DAVID MILLER, Bureau of Animal Industry, U. S. Dept. of Agr., Washington, D. C. *J. Dairy Sci.* 18, 4, p. 259, April, 1935.

Evidence is presented that a coagulant of hydrochloric acid and pepsin produces a truer picture of the curd characters of milk and simulating gastric condition than the calcium chloride-pepsin coagulant as used by Hill. The proposed coagulant contains 0.45 grams of pepsin per 100 cc. of 0.4 per cent hydrochloric acid. Holstein, Jersey and Goat milks when given various treatments such as boiling, skimming and homogenizing, showed more uniform changes in curd tension by the hydrochloric acid coagulant than by the calcium chloride. When the milks were boiled for one minute, the curd tension values showed a drop by both methods. The acid coagulant showed a much greater drop in the case of the Holstein and Jersey milks. The values obtained were within or near the limits of soft curd milk. D.M.

Preliminary Observations on Certain Seasonal Variations in the Physical Properties and Nutritive Value of Cow's Milk Serum. F. E. STIRN, C. A. ELVEHJEM, AND E. B. HART, Dept. of Agric. Chem., Univ. of Wisconsin, Madison, Wisconsin. *J. Dairy Sci.* 18, 5, p. 333, May, 1935.

The serum of winter produced milk showed physical characteristics at variance with those of summer produced milk. It was clarified with greater difficulty. An adjustment of the salt balance and pH improved somewhat the technique used for the preparation of the serum from winter milk. The time at which these changes occur varies from year to year.

The serum of winter produced milk showed lower nutritive value than

that of summer produced milk as measured by its use in supplementing a highly purified diet as a source of the vitamin B complex.

The significance of these studies lies in the relation of fresh plant tissue as contrasted with field dried material to subtle changes in the milk secreted.

F.E.S.

Behavior of Caseinate Sols in a Study of a Hysteresis-like Phenomenon in the Rennet Coagulation of Heated Milk. M. E. POWELL AND L. S. PALMER, Div. of Agr. Biochem., Univ. of Minnesota, St. Paul, Minnesota. *J. Dairy Sci.* 18, 6, p. 401, June, 1935.

When artificial "milks" of calcium caseinate-colloidal calcium phosphate are heat-treated at 60° C. and 85° C. and coagulated at 40° C. with rennet at various intervals after heating a progressive loss of coagulability results as rennet addition is delayed. The presence of both the calcium caseinate fraction and the colloidal calcium phosphate fraction during heat-treatment is essential for hysteresis; heating either fraction alone before addition of the other fails to alter the coagulability. Heat-treating the colloidal calcium phosphate fraction causes a marked peptization of colloidal material as well as a decrease in pH, both effects being largely masked by the presence of the caseinate during heating. Heat-treating calcium caseinate "milks" in which oxalic or arsenic acids were substituted for the phosphoric acid fails to produce the hysteresis. A much greater increase in cataphoretic velocity results when calcium caseinate-phosphate "milks" are heat-treated than when a calcium caseinate sol is similarly treated.

M.E.P.

Influence of Season and Advancing Lactation on Butterfat Content of Jersey Milk. R. B. BECKER AND P. T. DIX ARNOLD, Florida Agr. Exp. Sta., Gainesville, Florida. *J. Dairy Sci.* 18, 6, p. 389, June, 1935.

Analyses of variance of average monthly butterfat tests in 293 lactations by Jersey cows in Florida ranged between 4.76 per cent in August and 5.46 per cent in December. Fat tests dropped from 4.96 the first month after calving in the Florida Jerseys, to 4.59 per cent in the second month, increasing gradually thereafter to 5.55 per cent in the twelfth month.

A.C.D.

Period of Lactation and the Direct Titratable Chloride Value of Milk. PAUL F. SHARP AND EARLE B. STRUBLE, Dept. of Dairy Industry, Cornell Univ., Ithaca, N. Y. *J. Dairy Sci.* 18, 8, p. 527, Aug., 1935.

The direct titratable chloride value fell rapidly during the first few days of lactation, reached a minimum, increased slightly during the first

60 per cent of the lactation period and then increased rapidly, particularly during the last 10 per cent of the period. The chloride value bears an inverse relation to the amount of milk produced. At the same level of production Holstein milk was found to be higher in chloride than Guernsey or Jersey milk.

The first and last milk drawn from quarters infected with mastitis was found to be high in chloride and pH and low in titratable acidity, while the middle portion often approached or fell within the range of normal milk. The fraction of the total milking of the quarter of the udder and the different quarters themselves had little effect on the chloride values of the normal milk from healthy cows. P.F.S.

Investigations on the Milk of a Typical Herd of Shorthorn Cows. III. Nitrogen Distribution, Chloride, Lactose, Copper and Iron Content Over a Period of Two Years. WILLIAM LEWIS DAVIES, National Inst. for Res. in Dairying, Univ. of Reading, England. *J. Dairy Res.* 6, 3, p. 363, Sept., 1935.

Weekly samples of typical milk from a small herd of Shorthorn cows were taken over a period of two years. In all, 96 samples were analyzed for chlorine content and nitrogen distribution, 75 samples for lactose content, and 24 samples for copper and iron. The following average percentage composition is arrived at:

Fats	3.24 per cent
Solids not fat	8.90 per cent
Lactose	4.81 per cent
Chloride	0.086 per cent
Total protein	3.00 per cent
Casein	2.45 per cent
Albumin	0.428 per cent
Globulin	0.147 per cent
Copper	0.000041 per cent
Iron	0.000196 per cent

The magnitude of the variations in the amount of the total nitrogen accounted for by the albumin and globulin singly is higher than for any of the other nitrogen fractions, although the sums of both naturally show little variation. The albumin was found to vary 14 per cent on either side of the mean, and the globulin 23 per cent. Contrary to general opinion, the mean figure for globulin nitrogen is definitely less than for non-protein nitrogen. The general nitrogen distribution on a percentage basis in milk given by Davies is modified to: Casein, 77; Albumin, 13; Globulin, 4; Non-protein, 6.

Generally the change in the percentages of the constituents studied occurred in the same direction simultaneously. This additive effect caused

the solids-not-fat content during the drought of 1933 to drop below 8.5 per cent on five occasions. The two main constituents concerned, of course, were the lactose and the casein. The variation in the lactose content was less than for the protein.

The chloride content generally varied inversely with the solids-not-fat content. No seasonal variation was observed in the copper and iron contents of samples of milk taken once monthly. H.A.B.

The Yield and Composition of the Milk of the Ewe. W. GODDEN AND C. A. PUDDY, The Powell Res. Inst., Aberdeen, Scotland. *J. Dairy Res.* 6, 3, p. 307, Sept., 1935.

Figures are given for the yield, specific gravity and detailed composition including ash constituents for the milk produced by eight Cheviot ewes.

A.C.D.

The Influence of High Environmental Temperature on the Secretion and Composition of Milk, a Preliminary Note. S. BARTLETT, The National Inst. for Res. in Dairying, Univ. of Reading, England. *J. Dairy Res.* 6, 3, p. 283, Sept., 1935.

Two pairs of cows were housed alternately at 40° F. and 80° F. and the effect on the composition of the milk noted. The higher temperature reduced the milk yield 0.16 pound per day and the fat percentage 0.04, neither change being considered significant.

A significant change was observed only in the case of the solids-not-fat, which on the average decreased 0.153 per cent due to the higher temperature. Regarding the other constituents of the milk and blood, the changes, if any occurred, were not measurable in this small scale experiment. It is concluded that high temperature is not the only factor responsible for milk of low chemical quality produced during summer months. H.A.B.

Studies of the Values of Different Grades of Milk in Infant Feeding. J. A. NEWLANDER AND C. H. JONES, Animal and Dairy Husbandry Dept., Vt. Agr. Exp. Sta., Burlington. *Vt. Agr. Exp. Sta. Bul.* 389, May, 1935.

The relative values of normal cow's milk, evaporated milk, powdered whole milk (two brands) and remade milk for infant feeding were studied in trials with baby pigs.

It is generally held by nutritionists that the results attained with young pigs may be applied to the feeding of the human infant because of the physiological similarity of their digestive systems. It is recognized of course that a pig at birth is more fully developed than is the babe and that it matures more rapidly; however, it may be assumed with some degree of assurance that

each week of early porcine life approximately corresponds to two or three months of an infant life. The feedings began at two days after birth and continued until the pigs were from two to five weeks of age, which periods would resemble approximately the initial year in human life.

Comparisons, based on the vigor of the animals while on trial, on the total gains, on the amount and economy of dry matter gain and on the body composition, show that the normal milk which was used as the base of all the trials proved best, the evaporated milk and powdered whole milk No. 2 were second best, while remade and powdered whole milk No. 1 were somewhat less serviceable.

Compared with pigs on sow's milk, favorable dry matter gains were made on normal, evaporated, and powdered milk No. 2; less favorable gains on powder No. 1 and least favorable gains on remade milk. In economy of dry matter gains the normal milk ranked first, followed closely by the evaporated and powdered milk No. 2 and less closely by the powdered No. 1 and remade milks.

Marked changes in body composition occurred coincident with increased age. Baby pigs at birth contain about 80 per cent water, protein comprises the greater part of their dry matter content averaging over 60 per cent, while their ash and fat contents each average 17 per cent, the fat to protein ratio being about 1:3.6. As age advances the dry matter and fat percentages decidedly increase. In a well-developed pig at weaning age the dry matter percentage will be approximately 50 per cent greater and of fat 150 per cent greater than they are at birth, and the relative percentages of fat and protein will be nearly equal.

Stomach capacities of the check and experimental pigs were determined at slaughtering time. The data obtained indicate that, with the possible exception of some of the initial feedings, there was ample room for the quantities of milk given at a feeding.

J.A.N.

Milk-distribution Costs in West Virginia. I. A Study of the Costs Incurred by 22 Plants During 1933. R. O. STELZER AND L. M. THURSTON, Morgantown, W. Va. W. Va. Agr. Exp. Sta. Bul. 266, 1935.

A study of the 1933 records from 22 milk-distributing plants in West Virginia was made. The cost of milk distribution for these plants was found to be \$2.05 per 100 pounds of milk purchased. These plants paid an average of \$1.64 per cwt. for the milk used for fluid sales purposes, which included fluid milk, coffee- and whipping-cream, buttermilk, skim milk, chocolate milk, cottage cheese, and surplus milk in the form of cream. The total cost of milk and cost of distributing average \$3.69 per cwt. or 7.94¢ per quart. The cost of milk to the various plants ranged from \$1.26 to \$2.25 per cwt. and the cost of distribution from \$1.41 to \$2.91, whereas the total of these two items ranged from \$3.05 to \$5.02 per cwt. The cost of milk to plant did not

represent the price paid the producer but was the cost of the milk delivered at the plant.

Labor was the largest item of distributing cost, amounting to 84.1¢ per cwt., equal to 41 per cent of the distributing cost. Depreciation costs averaged 22¢ per cwt., the range being from 8.4¢ to 33.4¢. Depreciation varied considerably for the individual plants because of the rate of depreciation charged, kind and amount of investment per plant, amount of property rented, and volume of milk handled. The plants that rented the land and buildings used in distributing milk had the lowest depreciation costs.

Supplies, repairs, taxes, insurance, and such other items incurred in the care and operation of the buildings and equipment cost 57.5¢ per cwt. The remaining distribution costs for the 22 plants were as follows: loss of milk, 4.7¢; bad debts, 7.0¢; interest costs, 17.7¢; advertising, 2.2¢; and all other costs, 9.8¢ per cwt. of milk purchased.

An average of 1,663, 034 pounds of milk were purchased in 1933 by each plant, the largest plant purchasing more than 5,000,000 pounds and the smallest, 203,228. Of the total quantity of milk purchased, approximately 53 per cent was sold as fluid milk, 19 per cent as fluid cream, and 23 per cent as other products, the remaining 5 per cent being lost or not accounted for in the disposal figures. The data indicate that approximately 70 per cent of the sales of milk and cream were at wholesale prices and the other 30 per cent at retail prices.

The gross value of the sales was \$3.57 per cwt. of milk purchased for 17 of the 22 plants. This represents a gross sales value of 7.67¢ per quart of milk. These same 17 plants paid \$1.54 per cwt. of milk. The difference between the gross sales value and the cost of milk, amounting to \$1.93 (\$3.57-\$1.64) was retained by the plants and represents their average spread. The total operating cost of these 17 plants was \$1.91 (excluding interest not paid), which indicates that the average profit was 1.2¢ per cwt. of milk purchased. A profit of 1.2¢ per cwt. was equal to a return of 0.44 per cent on the average investment for the year, or is equal to 1¢ profit for each 39 quarts of milk equivalent sold.

L.M.T.

A Study of the Consumption of Dairy Products in Minneapolis in 1934.

WARREN C. WAITE AND REX W. COX, Div. of Agric. Economics, Minn. Agr. Exp. Sta., St. Paul, Minn. Minn. Agr. Exp. Sta. Bul. 311, Oct., 1934.

Information for this study was secured by enumerators from 2187 families, which included 8783 persons, living in 228 selected areas in the city. Rates of consumption are given for milk, cream, butter, cheese, evaporated and condensed milk, and ice cream. The authors present an analysis of the factors influencing rates of per capita consumption in the various families and consider certain phases of competition between products.

The consumption of dairy products as a whole tends to increase with income. In the lowest income group, the monthly consumption of butterfat in all products average 3.11 pounds per capita and rose steadily to 5.14 pounds in the highest income group. The number of children in the family is the dominant factor in determining the rate of milk consumption, with income less important than in the case of other dairy products. The rate of butter consumption is largely determined by the per capita income of the family. Cream is purchased almost exclusively by families in the higher-income groups. Condensed and evaporated milk are used largely as a substitute for fluid milk and cream and per capita consumption is largest in the low-income groups. Cheese is consumed at more nearly uniform rates in all groups than the other manufactured dairy products, although there is a higher rate of consumption in the high-income groups. The consumption of ice cream varies largely with income. Increases in income may be expected to increase materially the fluid milk and butter consumption in the low-income group; increase butter consumption slightly, cream consumption a great deal, and fluid milk slightly in the medium-income group, and change consumption hardly at all in the higher-income group. Twenty-two tables of data are reported.

S.T.C.

MISCELLANEOUS

Effect of Various Phases in the Manufacture of Casein by the Natural Sour Method on its Physical and Chemical Properties. D. R. THEOPHILUS, H. C. HANSEN, R. S. SNYDER, R. E. WOOD, AND R. L. OLMSTEAD, Dept. of Dairy Husb., Ida. Agr. Exp. Sta., Moscow, Idaho. *Ida. Agr. Exp. Sta. Bul.* 212, May, 1935.

Results obtained from the analyses of 20 lots of casein made by the natural sour curd method under controlled conditions showed that with standard methods a uniform, high quality casein could be produced.

It was possible to control color, odor, solubility, yield, and nitrogen content within narrow limits. Viscosity, ash, pH, and conductivity were not so easily controlled, while moisture and fat contents were extremely variable. Of the chemical and physical properties studied, total and free acidity were of little value because of the difficulty in determining the exact end point.

The variations in the manufacturing process that had the greatest effect on quality were the thoroughness of washing, acidity at time of coagulation, and setting and cooking temperatures. Color, odor, solubility, viscosity, pH, and conductivity determinations appeared to be the best indexes of quality. The results also showed that by varying different steps in the manufacturing process casein could be made to meet any definite specifications. D.R.T.

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ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

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ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

BUTTER

Intensifying Flavor and Aroma in Butter. H. A. RUEHE AND R. J. RAMSEY, Dept. of Dairy Husbandry, Univ. of Illinois, Urbana, Ill. *Milk Plant Monthly*, 24, 2, p. 40, Feb., 1935.

The flavoring principles of starter (diacetyl and certain volatile products) were removed by steam distillation. When the distillate was added to cream the flavor and aroma of the cream were increased without increasing the acidity. Such treated cream yielded a butter of high aroma similar to ripened cream butter, yet the butter was low in acidity.

Starters to be used for distillation can be made to produce several times the normal amount of flavoring substances. G.M.T.

CHEESE

The Prevention of Some Common Defects in Cottage Cheese. W. V. PRICE, Univ. of Wisconsin, Madison, Wis. *The Milk Dealer*, 24, 6, p. 46, March, 1935.

Sour flavor: Appearing immediately after manufacture may be due to the presence of too much whey in the curd, due to low temperatures of cooking, to lack of firming of the curd before draining, or to lack of draining of the curd before washing.

When the curd turns sour in storage, the defect may be attributed to too much moisture in the curd, improper washing, holding at unsuitable temperatures, holding for too long a period, or the wrong kind of starter. Too much moisture in the curd can be corrected by heating to a higher temperature and firming the curd before draining off the whey. Improper washing may be due to applying the water before all the whey is removed, to the use of too small an amount of water, or to incomplete draining away of the wash water. To inhibit the growth of bacteria, a storage temperature of 32° to 35° F. should be used. A starter which persistently develops more than 0.80 per cent of acid in the mother culture in a period of 16 hours at 70° F. should be discarded.

Fermented, yeasty, and bitter flavors: Commonly caused by the growth of certain micro-organisms which may be found in the cheese because (1) raw milk was used, (2) the milk was improperly pasteurized, (3) of the use of inferior starter, (4) too much whey in the curd or improper washing of the curd, (5) improper storage conditions, or (6) unclean equipment.

Only properly pasteurized milk should be used in making cottage cheese. Starters should be carefully watched for the first indications of undesirable

flavor, weakness or inactivity, and should be discarded when such signs appear. Cottage cheese is almost as perishable as milk or cream under the same storage conditions. Strict cleanliness, efficient scalding or sterilization with chlorine solutions, and drying of equipment and utensils are as necessary in the manufacture of cottage cheese as in handling milk of high quality.

Unclean flavors: May be caused by lack of cleanliness, by conditions of manufacturing, by feed, or by storage conditions. Every precaution should be taken to select milk with a clean flavor for the production of cottage cheese. Strict cleanliness and adequate sterilization are essential. If milk free from feed flavors cannot be obtained the use of a starter of high quality, careful pasteurization, and thorough washing of the curd seem to be the next most efficient steps to control feed flavors. Storage should be only for short periods, at 32° to 35° F., in clean containers, and in clean refrigerators free of odors.

Mouldy flavors: Usually due to the growth of mould, of which there are many types; may be controlled by reducing the amount of surface exposed to the air, shorter storage periods, or by packing the cheese under vacuum. C.J.B.

Common Defects in the Body of Cottage Cheese. W. V. PRICE, Univ. of Wisconsin, Madison, Wis. *The Milk Dealer*, 24, 7, p. 34, April, 1935.

The condition known as *hard* and *dry* is caused (1) by improper cutting of the curd and (2) by lack of control of the firming process. Curd must be cut into pieces of uniform size. Curd knives and careful stirring are necessary to produce minimum breakage. Temperature of heating must be controlled to suit the size of the curd particles. Checking the firmness of the curd by thoroughly chilling in cold water is a helpful method to avoid overworking.

The condition known as *tough* and *rubbery* type cheese is caused by too much rennet or the development of too little acid. Carefully measure the rennet and determine time for cutting the curd by the acid test.

The whey used for determining the acidity should be pipetted from several inches below the surface of the curd and then centrifuged in order to obtain a clear whey for measuring the titratable acidity.

The defect known as *soft* and *mushy* may be caused by (1) improper pasteurization, (2) insufficient heating of the curd, (3) the washing treatment, (4) excess acidity, or (5) the creaming of the curd.

Pasteurization, whether accomplished by the flash method at 160° to 165° or by holding 30 minutes at 143° to 145° F., should be carefully controlled. The time of dipping should be determined by the size and firmness of the

curd particles. The cubes of curd should be plump and firm and should have no soft centers. The draining process should not be hurried and excessive washing avoided. Acidity of whey should not exceed 0.55 per cent and should be controlled by time of cutting the curd, amount of starter used, and by careful use of carefully checked thermometers. The percentage of butterfat in the cream used for creaming should depend upon the moisture content of the curd.

Low yields of cheese are caused by (1) high acidity, (2) excessive amounts of rennet, and (3) careless handling of the curd. These may be avoided by carefully controlling the acidity, measuring the amount of rennet used and careful handling of the curd.

A conservative estimate of yield of cottage cheese can be obtained by dividing the casein content of the milk by the factor 0.16. The casein content can be calculated fairly accurately by the formula: Per cent casein = 2.1 plus (fat in milk - 3) 0.4. C.J.B.

A Gas Defect of Cream Cheese. W. J. CORBETT, W. J. FRAZIER AND W. V. PRICE, Univ. of Wisconsin, Madison, Wis. *The Milk Dealer*, 21, 3, p. 38, Dec., 1935.

A report is made of a study of a gas defect found in cream cheese, especially cream cheese flavored with pimientos, sweetened crushed pineapple, or sweet-pickle relish. This gas defect was found to be due to yeasts.

C.J.B.

ICE CREAM

A New Bacterial Species Isolated from Strawberries. HELEN F. SMART, U. S. Dept. of Agr., Washington, D. C. *Jour. Agr. Res.*, 51, 4, p. 363, 1935.

In a microbiological investigation of frozen-pack fruits the author reports a new bacterial species for which the name *Achromobacter delmarvac* is proposed. The organism was isolated from fresh strawberries found in four localities in Delaware, Maryland and Virginia. It was the predominating organism in the berries studied whether or not they were washed before sampling, and it occurred principally on the outside of the fruit. So far as is known the organism has no effects on the texture, flavor, appearance or healthfulness of fresh or frozen strawberries.

The organism is a nonmotile, Gram-negative nonsporeforming short rod; agar colonies are round, raised, glistening, smooth, entire margin, amorphous. It grows best at 26 to 31° C. (78.8 to 87.8° F). In milk it forms acid curd in 12 to 14 days; color of milk becomes chocolate brown. L.M.T.

Freezing Fresh Milk. Is this Method of Preserving a Solution to the Surplus Problem? RALPH V. GRAYSON, Polar Products, Inc., Atlanta, Ga. *The Milk Dealer*, 24, 7, p. 30, April, 1935.

The author suggests freezing fresh milk as a method of overcoming the surplus problem. A high-grade milk produced in strictly sanitary dairies was furnished in earthen containers and pasteurized at 145° F. for 30 minutes, homogenized, filled into the receiving reservoir of the Grayson de-aerating-freezing unit, where a vacuum of 28.80 inches was maintained for 20 minutes, after which it was frozen to a slush in four and one-half minutes, still under vacuum. From the freezer the milk slush was filled into one-gallon stone jugs of thermic type and sealed under 15 inches vacuum. The jugs were placed in the Grayson-Foster freezing unit, which freezes at -45° F., and frozen hard in one hour and 55 minutes. The product was then stored at 0° F.

This product was examined at intervals of 30 days and the quality of the product was found to be excellent and comparison with fresh milk at each interval indicated very little, if any, change in the product.

It was found by Dr. Leah Ascham of the Department of Home Economics, Georgia Experiment Station, that milk frozen by the quick-frozen method and tested after being stored for 4 months and two years, respectively, showed no significant lowering of vitamin A or vitamin G content over that found in fresh milk from the same source.

Committee comments: No data were presented on the cost of preserving milk by freezing. C.J.B.

The Continuous Freezer. A Symposium. *Proc. 35th Ann. Conv. Intern. Assoc. Ice Cream Mfgs.*, 2, p. 85, Oct., 1935. **A. Its Effect on the Texture of Ice Cream.** W. H. E. REID, Dairy Dept., Univ. of Mo., Columbia, Mo.

Ice cream mixtures ranging in butter fat from 8 to 18 per cent were frozen in the continuous freezer and hardened at a temperature of -15° to -20° F. with forced air circulation. As the butterfat content was increased in increments of 2 per cent the texture changed from a slightly coarse to a smooth texture until 14 per cent fat was reached. From 14 to 18 per cent fat an increasing tendency towards a salvy texture resulted. Mixes varying in serum solids from 8 to 15 per cent were frozen. Ice cream with 8 per cent serum solids was grainy in texture; with 10 per cent serum solids the grainy texture was entirely absent, above 10 per cent serum solids the ice creams were too close in texture and inclined to be brittle. Variations in sugar from 12 to 20 per cent showed very little difference in texture at 12 and 14 per cent levels. Sugar percentages of 16, 18 and 20 produced ice creams which were very close in texture and slightly crumbly in body. As the

gelatin content was increased from 0 to 0.3 per cent in increments of 0.1 per cent the ice creams became smooth and closer in texture. A gelatin content of 0.5 per cent produced ice cream which was too smooth and close in texture.

Ability to control the overrun accurately with the continuous freezer aids in the manufacture of a smooth textured, uniform ice cream. The small crystal structure in the ice cream is conducive to a more pronounced flavor. Some manufacturers have decreased their flavoring costs by changing to the continuous freezer.

The comparison of ice creams frozen on three different types of freezers revealed that the continuous freezer produces smaller ice crystals than other types of freezers. This is attributed to the high speed of the mutator in the continuous freezer, the rapidity of freezing, and the low drawing temperature of the ice cream. Microphotographs which accompanied the article reveal the variations in crystal structure observed in the study.

B. Its Use in Packaging Ice Cream. ALLYN B. WICKS, H. P. HOOD AND SONS, Inc., Cambridge, Mass.

During the development and early use of the continuous freezer, this company followed the viewpoint that the continuous freezer would not be accepted unless it produced an ice cream of equal or better quality than that made in the batch freezer and that it be applicable to 100 per cent of the product made. The seemingly biggest problem was the filling of packages up to one quart in size. A set of extensions have been constructed for the continuous freezers to suit the shape and size of the varied style and sizes of containers used. By means of a clamping arrangement these extensions are readily interchangeable. The changes are made with sufficient ease that production is not slackened when changing from one sized package to another. Loss of time and product in changing flavors is kept at a minimum by synchronization of all freezer and pump speeds and by operator control. The time loss with batch freezers, hopper, and filling machine arrangement with attendant wash out exceeded that for the continuous freezers.

The following figures show the gallons of packaged ice cream manufactured per man hour. The figures are based on actual plant operations for a representative week in 1934 with a batch, hopper, machine-fill method versus a similar week in 1935 with continuous freezers and direct filling.

TYPE PACKAGE	1934	1935	GAIN
One-half pints	21.4	22.3	4.2 per cent
Pints	26.6	40.7	53.0 per cent
Fifths	34.8	39.7	14.0 per cent
Quarts . . . . .	..	38.1	

The capacity per machine hour is also greater with the continuous freezer than with the batch freezer. With batch freezers, in 1934 a capacity of 90 gallons per machine hour was realized; in 1935 with the continuous freezer, operation at a capacity of 130 gallons per man hour was attained.

Another type of packaging done successfully by the use of two continuous freezers is the direct filling of center mould packages. Center moulds such as sultana rolls, nut rolls, or ice cream with a core of chocolate fudge syrup, fruit, or other syrups, can be made in this manner. The direct filling of souffle cups, with a space at the top for garnishing, has been done with the continuous freezer. Thirty inch slabs of ice cream have been cartoned, then stripped of the carton after hardening, for use in slicing machines.

C. Comparative Operating Costs. H. F. DEPEW. Luick Ice Cream Co., Milwaukee, Wisconsin.

Comparative operating costs vary with the size and number of freezers, number of operators, condition of freezers, temperature of refrigerant and the use of conveyors. The efficiency of operation depends largely on the type of installation used. However, the continuous freezer is more efficient for packaging ice cream than batch freezers; as for freezing bulk the type of installation is the deciding factor.

Comparative operating costs over a ten weeks' period in four plants on batch freezers as compared with four plants using continuous freezers follow. The number of units frozen per labor hour were:

Continuous freezers	74.1 units
Batch freezers	57.6 "

The average labor cost of freezing were:

Continuous freezers	\$.0139 per gal.
Batch freezers	.0202 " "

The maintenance costs in one plant averaged \$25.00 a year per batch freezer and \$100.00 a year for a continuous freezer. In another plant repairs (excluding labor cost) averaged \$27.08 per freezer with continuous freezers for a period of six months. The lower load per gallon of ice cream frozen appears larger with batch than with continuous freezers.

The general conclusion is drawn that comparative operating costs are hard to figure on an equitable basis because of the many variable conditions which exist. However, the difference in operating costs under the two systems is not great enough to be a major factor in determining the type of freezer which should be purchased.

M.J.M.

The New Era in Ice Cream Sanitation. F. W. FABIAN, Dept. of Bacteriology and Hygiene, Michigan State College, East Lansing, Mich.

Proc. 35th Ann. Conv. Intern. Assoc. Ice Cream Mfgs., 2, p. 56, Oct., 1935.

There is evidence of a trend towards more adequate state and city sanitary regulations governing ice cream production. In 1929 only two states and one province required pasteurization of the mix. Now 26 states and provinces (6 other states require the use of "Grade A" or pasteurized milk products) require pasteurization of mix or milk products used. In 1927 one state had a maximum bacterial count established for ice cream; now 12 states have such standards.

A regulation requiring that ice cream be frozen at the place of pasteurization is recommended. It is suggested that another requirement be that the mix must flow in a closed pipe line from the pasteurizer to the freezer. The Michigan law requires that the pasteurization time be dated and holding time before freezing be limited to seven days. A time limit of no more than 24 to 48 hours is ample but freezing within 2 to 4 hours after pasteurization is recommended as the ideal. Dating of ice cream at the time of freezing is recommended.

The author proposes that ice cream be graded. Grade A ice cream should be made from fresh milk, cream, and condensed milk and should meet certain chemical and bacteriological standards. Grade B ice cream should be that made from milk products such as powdered milk, frozen cream, condensed milk (older than 24 hours), butter, etc. Both Grades A and B should meet the same sanitary and chemical standards. A third Grade, Grade C ice cream is proposed. This would include ice creams of lower butter fat content than the standard for Grades A and B.

The suggestion is made that schools for the instruction of workers in dairy plants in the fundamentals of sanitation be maintained. M.J.M.

Another Year's Experience with Single Service Cans. A Symposium.

Proc. 35th Ann. Conv. Intern. Assoc. Ice Cream Mfgs., 2, p. 70, Oct., 1935.

1. RIDGWAY KENNEDY, JR. Abbotts Dairies, Inc., Philadelphia, Pa.

Paper cans were found to be more satisfactory than metal cans because delivery trucks are cleaner (since no dirty cans need be returned), quieter, and lighter by about 1000 pounds per load. The production plant operates satisfactorily on paper cans because the necessity for can washing and rehandling of metal cans is eliminated. Operating expenses are lowered by the use of paper cans.

Paper cans were found to be less satisfactory for dipping because of a weaker side wall than metal cans. The problem for disposal of the paper cans is also annoying to the retailer.

The cost of paper cans has averaged slightly more than metal cans. However the plant overhead is decreased and trucking costs are lowered by the use of paper cans. These savings more than offset the higher cost of the paper cans.

2. J. H. LANDESS. Fortunes, Inc., Memphis, Tenn.

The cost of using metal cans and jackets, including express on returned cans, can washing, labor, water, steam, and depreciation charges was \$.0679 per gallon of ice cream. The cost of paper cans, including shippers, tape, dry ice, was \$.0916 per gallon. However average express rates with metal cans was 17 cents per gallon of ice cream while with paper cans the average was 9 cents per gallon. Adding the express rate to each of the initial cost figures, a difference of \$.0563 per gallon in shipping costs exists in favor of the paper cans. The use of paper cans instead of metal cans for public truck or express deliveries is cheaper, especially when the distance exceeds 50 miles.

Paper cans have been improved very little since first appearing on the market. Trouble was experienced with the tops and bottoms pulling loose. In dipping, the dipper catches on the metal stitching on the side of the can. Trouble was experienced with the ice cream getting soft near the center of the cans and shrinking during shipment.

3. J. MORRISSEY. De Coursey Creamery Co., Kansas City, Kansas.

This company adopted the single service container for shipping ice cream. The paper can reduced shipping costs due to the light weight of the can. Shrinkage of ice cream in the can on long distance shipments has been a troublesome factor.

Single service cans have many advantages for city delivery. They are cleaner, easier to handle, and eliminate the necessity of washing returned cans.

4. R. J. QUIRIE. Silverwood's Ltd., London, Ontario, Canada.

This writer has used the heavy metal can, the light weight metal can and the paper cans. In changing the buyer of ice cream over from the heavy metal can to the paper can, the light weight single service metal can has bridged the gap between the two, thus making the transition easier.

The dry ice and light weight can cannot compete with the jacket and heavy can within an area of about 100 miles; here the jacket without dry ice is more satisfactory. For longer shipments the use of the single service can is cheaper because there is no empty can to return and shipments are lighter. The single service cans also eliminate the cost of retinning cans.

5. S. SCISM. DeLuxe Ice Cream Co., St. Louis, Mo.

Paper cans were first used by this company for express shipments and now are used for city delivery as well. Many of the dealers in St. Louis are buying the cans cooperatively to keep down costs.

The use of paper cans makes possible more cleanly conditions in delivery as well as in the production of ice cream. Another advantage of the paper can is that it can be dated conveniently so that the age of any can of ice cream is known.

6. **CARL KOERVER.** Pioneer Ice Cream Brands, Inc., Brooklyn, N. Y.

The primary purpose of changing to paper cans was in the interests of sanitation and better service to dealers. However, the company has experienced savings in all phases of the business through the use of paper cans. Loading out trucks is more rapid and unloading returned trucks is simple because there are no returned cans. Since the paper cans are light, transferring ice cream to branch plants has been made easier than when metal cans were used.

The appearance of the manufacturing plant, loading platform and trucks has shown sufficient improvement, due to the use of paper cans, to justify their use even though no saving of money should result from the change.

M.J.M.

Power, Light, Heat, Refrigeration, Water—Their Costs and Conservation. A. H. BAYER, General Ice Cream Corp., Schenectady, N. Y. Proc. 35th Ann. Conv. Intern. Assoc. Ice Cream Mfgs., 2, p. 64, Oct., 1935.

The importance of economy in plant operation is stressed by the author who gives the following cost figures as existing in plants with which he is familiar: The cost of the power and refrigeration for mixing varies from \$.0097 to \$.0358 per gallon, the average being \$.0193. For freezing a gallon of ice cream power and refrigeration costs average \$.0093 with a range of \$.002 to \$.0382; for hardening of ice cream costs varied from \$.0126 to \$.0774 per gallon, the average being \$.0350. The total power and refrigeration costs per gallon of ice cream for mixing, freezing and hardening averaged \$.0573 per gallon with variations from \$.0339 to \$.1001. Obviously, if one plant is doing a complete job for power and refrigeration at a cost of \$.0339 per gallon and another plant at a cost of .10 per gallon, there must be a lesson in economy to be learned in the plant with low costs.

The author tabulates about 80 different factors which should be considered in a cost study of power, heat and refrigeration. In one plant careful consideration of operating costs resulted in a saving of \$10,000 per year. In another plant changes were made so that heat from exhaust steam could be utilized. Saving in coal for the first year paid for the change.

M.J.M.

What is a Practical Bacterial Standard? R. C. FISHER, R. F. Worden and Sons, Inc., Waterbury, Conn. Proc. 35th Ann. Conv. Intern. Assoc. Ice Cream Mfgs., 2, p. 60, Oct., 1935.

The author stresses the fact that bacteria counts are only estimates and have value only in that they are measuring sticks to sanitation of the product and plant. No conclusion can be drawn from one determination. Arithmetical averages of bacterial counts are likely to result in injustices. Logarithmic averages of not less than three consecutive counts are essential in order to draw fair conclusions.

Bacterial standards should be in the form of regulations rather than actual acts of legislation. Included in the regulations should be additional requirements such as (1) The standard procedure of the A.P.H.A. be strictly followed. (2) Laboratory technicians and those doing the field sampling should be fully qualified for the work. (3) Logarithmic averages of three counts taken within two weeks should be the basis of counts. (4) Samples should be collected only from unbroken packages.

Essentials in obtaining satisfactory bacteria counts are (a) pasteurization of the entire mix at 155° F. for 30 minutes; (b) thorough cleaning and sterilizing of all equipment; (c) constant checking of flavors, syrups, fruits and colors; (d) line run test to determine source of contamination when high counts occur.

The regulation in Connecticut of a maximum count of 100,000 bacteria by the standard plate method is not working undue hardship on the ice cream industry.

M.J.M.

MILK

Survey of Temperature Requirements of Milk in Transit. The Milk Dealer, 24, 6, p. 42, March, 1935.

A survey made by the Milk Dealer of cooling requirements reveals that most states appreciate the importance of cooling. The survey shows that those states having regulations have cooling requirements ranging from 50° to 70° F., the most frequent state requirement being 60° F. The municipal requirements for cooling are lower as a rule than the state requirements. The most frequent requirement for Grade A milk is 50° F. but requirements range as high as 55° F. Grade B milk is required to be cooled to 60° F. by the municipalities covered in the survey. Some municipalities make exceptions for morning milk that is to be pasteurized, or for milk to be pasteurized within 2 hours after milking. The requirements for the latter range from no cooling to cooling to 55° F., the most common requirement being 70° F.

C.J.B.

Some Recommended Methods for Producing Cultured Buttermilk.

DAVID A. MEYER AND LUTHER MINDLING. The Milk Dealer, 24, 6, p. 62, March, 1935.

Milk, skim milk, or reconstituted milk may be used for making cultured buttermilk. It should be pasteurized at 180° to 190° F. for one hour. After holding, cool to 68° in summer and 72° in winter and add one to three per cent good clean-flavored culture. The acidity should develop to .73 to .85 per cent, depending upon the method of handling and the type desired. When proper acidity has been developed, add from one-half to two pounds (as the trade demands) of salt per 100 gallons of buttermilk. Cool to 40° to 45° F. and bottle.

Flake buttermilk should contain from one-half to one per cent butterfat to give correct amount of flakes. Color should be added and the buttermilk churned at 60° to 72° until the flakes are about 1/32 to 1/16 inch in diameter. Not more than from 15 to 20 minutes of churning should be required. Churning a high-test buttermilk and then adding the flakes to a larger vat of buttermilk at 45° is also practiced. Other methods of making flake buttermilk are by spraying highly colored melted butter (about 1 ounce of color to one pound of butter) into buttermilk as another man stirs it with a stirring rod, or by adding highly colored butter to milk at 40° F. and vigorously whipping the milk.

Wheying off of bottled buttermilk may be due to too low pasteurizing temperatures; high setting temperatures causing the acidity to develop too rapidly; an acidity below 0.70 per cent; or storage at too high a temperature. More buttermilk, however, is spoiled by incorporation of air than by any other mechanical defect. Therefore care should be exercised not to unduly agitate the buttermilk by pumping, cooling, etc.

Too thick or too thin a body may be due to the type of culture, too high or too low acidity, too high pasteurizing temperature, insufficient or too much agitation, or excessive or not enough milk-solids-not-fat. The optimum body seems to be between .75 and .80 per cent acidity. The percentage of milk-solids-not-fat should be about 8.5.

Lumpiness may be caused by too high acidity of the milk, too high setting temperature, or insufficient agitation.

Cultures for buttermilk are a combination of *Streptococcus lactis* and *Streptococcus citrovorus*. Off-flavored cultures are caused by the incorrect balance between these two organisms or by contamination. Milk used for cultures should be the best quality obtainable. It should be pasteurized in the containers in which it is made at 190° F. for one hour, cooled to 68°, inoculated with good clean-flavored mother culture, incubated until well set (acidity about .85 per cent), and then cooled to 40° until used. Cultures not used daily may be transferred once or twice a week, or they may be frozen and held for several months.

Careful control of the development of acidity so that the *S. lactis* and *S. citrovorus* organisms grow in proper balance insures a good-flavored prod-

net. With proper precautions as to sterile equipment, a yeasty or malty flavor should never be encountered. Cultures which have developed bad or off flavors can sometimes be corrected by careful propagation, but the better practice usually is to discard such cultures. C.J.B.

The Manufacture of Popular European Special Milks. J. M. ROSELL, Univ. of Montreal, Oka, Quebec Canada. *The Milk Dealer*, 24, 7, p. 41, April, 1935.

The author calls attention to the large number of cultured milks which are being sold in Europe. Special attention is called to the large quantity of Yoghourt sold daily. Yoghourt results from the combined action of *Streptococcus thermophilus*, *Bacterium bulgaricum*, and *Lactobacillus yohourtii* on ordinary or one-third evaporated whole milk. Yoghourt appears to be more digestible than acidophilus, of at least equal therapeutic value, and commands wider use because of its pleasant taste. Its preparation is neither a difficult nor a lengthy process. C.J.B.

Stimulate Your Summer Sales with Orangeade. E. W. Thompson, Los Angeles, California. *The Milk Dealer*, 24, 8, p. 36, May, 1935.

The author states that facts which present themselves point to the conclusion that the sale and distribution of orangeade by milk dealers is profitable and satisfactory. C.J.B.

Milk and Its Mates. G. H. ROTHE, Southern Division, California Dairy Council. *The Milk Dealer*, 24, 9, p. 33, June, 1935.

The author calls attention to the amount of advertising milk receives by being teamed with other products such as flavoring extracts, soups, gas, and life insurance. The conclusion is drawn that there is more advertising for milk paid by "team mates" than is placed by the milk industry itself. The public is beginning to view milk through the eyes of other industries, and unless the milk industry does more advertising of its own, time may come when the public generally will regard milk as a secondary rather than primary substance. C.J.B.

Art of Whipping Cream Acquires a Scientific Finesse. New Device Assures Consumer 100 Per Cent Whipping Success. G. FREDERICK SMITH AND C. A. GETZ, Univ. of Illinois, Urbana, Ill. *The Milk Dealer*, 24, 9, p. 36, June, 1935.

A new patented device and process for making and dispensing whipped cream. The device is similar to the familiar soda siphon bottle, but is unbreakable and has a removable dispensing nozzle. The dispensing nozzle is furnished to the consumer. The bottle, of 1 pint size, is delivered to the

consumer containing one-half pint of cream and charged with nitrous oxide gas at 75 pounds pressure per square inch. The charged bottle is kept in the ice box and by use of the dispensing nozzle the consumer can have whipped cream on a moment's notice. The device successfully whips fresh cream of any butterfat content from 20 to 40 per cent and the overrun may reach as high as 450 per cent.

C.J.B.

Nation-Wide Survey Reveals Trend in Sale of Chocolate Milk. The Milk Dealer, 24, 10, p. 38, July, 1935.

This survey shows that chocolate milk is recognized as an important sales item for the milk dealer. Of those reporting, 94 per cent of the mid-western dealers, 79 per cent of the southern dealers, 70 per cent of the eastern dealers, and 65 per cent of the far-western dealers sold chocolate milk. The majority of those contacted through the survey advised that they enjoyed a profit on chocolate milk equal to or exceeding that on milk sales.

C.J.B.

What Are the Sales Possibilities of Chocolate Milk? The Milk Dealer, 24, 10, p. 40, July, 1935.

Experience of dairies shows that some 80 per cent of chocolate milk volume is plus-volume of milk and not replacement volume. Main outlets for chocolate milk were found to be, 1st, retail routes and stores; 2nd, schools; 3rd, restaurants; 4th, factories; 5th, hotels and filling stations; and, 6th, stands.

C.J.B.

Further Facts on the National Trend in Chocolate Milk Sales. The Milk Dealer, 24, 11, p. 52, August, 1935.

Milk dealers favored bottle sizes for distribution of chocolate milk in various sections as follows: East: Pints 4.5 per cent, quarts 29 per cent, $\frac{1}{2}$ pints 66.5 per cent; Middle West: Pints 26 per cent, quarts 37 per cent, $\frac{1}{2}$ pints 37 per cent; Far West: Pints 22 per cent, quarts 61.5 per cent, $\frac{1}{2}$ pints 16.5 per cent; South: Pints 8 per cent, quarts 8 per cent, $\frac{1}{2}$ pints 84 per cent.

The sales in quart bottles were made for the most part on the retail routes. Some 72 per cent of the milk dealers who replied to the questionnaire and who centered their sales efforts on quart sales, reported an increase in chocolate milk sales over last year. Only 48 per cent of the dealers selling principally half-pints reported a similar increase.

The survey showed that the retail route customer is the most favorable outlet for chocolate milk.

C.J.B.

Scientific Feeding, Stable Labor Control Reduce Horse Route Costs.

REGIS LAFEURE, Horse and Mule Association of America. *The Milk Dealer*, 25, 4, p. 40, January, 1936.

The association's figures indicate that dairies with very large branches find it most profitable to use single horses on routes 20 miles in length, electric trucks on routes 20 to 30 miles in length, and gasoline trucks beyond the electric-truck zone. On the other hand, dairies with small branches find it more economical and efficient to use horses on routes up to 20 miles and gasoline trucks outside the horse zone. C.J.B.

Straining Milk on the Farm. A. C. DAHLBERG, N. Y. State Agric. Exp.

Sta., Geneva, N. Y. *N. Y. Agric. Exp. Sta. Cir.* 155, Dec., 1935.

Either single service cotton pads or filter cloths can be used for straining milk. Filter cloths are usually comparable to a good grade of outing flannel. Generally cotton pads remove more dirt than filter cloths but have less capacity.

The cotton pads may have a protecting gauze on one or both sides. A metal support in the bottom of the strainer is necessary to prevent tearing and a perforated disc is usually placed above the cotton to break the force of the falling milk so as to prevent channeling of the cotton fiber. No supporting grid is necessary for cloth. The cloth can be supported by an inside perforated disc or by an outside clamp.

It is important to strain milk while it is still warm. A strainer pad will handle three times as much milk at 90° F. as it will at 80° F. Hand milking usually produces warmer milk than machine milking. P.H.T.

Methods of Inspecting Milk at the Receiving Platform. J. L. HILEMAN,

Lab. Division, Dairymen's League, Syracuse, N. Y. *The Milk Dealer*, 25, 2, p. 30, Nov., 1935.

A description of the Dairymen's League system of inspecting milk at the receiving platform is given based upon odor of the milk at the platform and direct microscopic examination. C.J.B.

Cost of Distributing Milk in Los Angeles. JOHN MARSHALL, JR., Div. of

Markets, State Dept. of Agr., *California Pacific Dairy Rev.*, 38, 9, p. 16, Sept., 1934.

This study was financed by a trust fund, established by the Los Angeles Milk Industry Board with the State Department of Agriculture, Sacramento, California. This money was contributed equally by the producers and distributors of the sales area in accordance with the United States Department of Agriculture, License No. 17, for milk, Los Angeles, which became effective November 20, 1933.

The twenty-one distributors from whom costs were obtained handled approximately 75 per cent of all the pasteurized milk sold in the Los Angeles sales area during the year 1933.

In examining the data it was noted that the cost of distribution, plus the cost of the raw product, showed that the majority of the business of these concerns was being handled at a loss under present conditions. J.C.P.

First Truly Silent Horse Wagon. (No author given). Food Industries, 6, 9, p. 412, Sept., 1934.

Illustrations are presented showing the pneumatic tired milk wagons which were placed on the streets of New York City on August 28. The horses are also "silenced" by rubber covered shoes, which are made in the open-face form common to the familiar steel shoes.

Charts are presented showing comparative noises produced by the ordinary and converted milk wagons, and also the weight or relative pound pull required to start the two types of wagons from rest on two different kinds of pavement. J.C.P.

Dairy Refrigeration on Rural Electric Lines. E. C. EASTER AND M. L. NICHOLS, Alabama Polytechnic Institute, Auburn, Alabama. Alabama Exp. Sta. Bul. 241, April, 1934.

From this study the authors reach the following conclusions:

Retail dairies should have a refrigerating plant with a minimum of 15 pounds of "ice melting capacity" per 24 hours operation for each gallon of milk produced per day. Dairies producing milk for the wholesale market should have 10 pounds of "ice melting capacity" per 24 hours operation for each gallon of milk produced per day. By using well water in one section of the surface cooler the minimum capacity of refrigeration can be reduced 2.5 pounds. The refrigerator should not need to operate more than 18 out of 24 hours.

In terms of kilowatt-hours, retail dairies will require about 7.6 kilowatt-hours per month for each gallon of milk cooled per day, while wholesale dairies will require 4.6 kilowatt-hours per month for each gallon of milk cooled per day. P.H.T.

Soft Curd Milk Studies. M. H. BERRY, Univ. of Maryland, College Park, Maryland. Milk Plant Mo., 23, 10 and 11, 1934.

It was found in this investigation that holding milk cold for one week did not significantly change the curd tension provided that the acidity did not increase.

The curd tension of milk from individual cows did not change noticeably between milkings over a short period of time. Noticeable exceptions to this

general observation were recorded. Colostrum forms a very hard curd. This softens materially as the milk becomes suitable for human consumption.

Freezing and thawing milk tended to increase its curd tension. Ordinary pasteurization at 143° F. for 30 minutes did not materially change curd hardness. Temperatures of 180° F. or above for 15 to 30 minutes reduced the curd hardness. Bringing milk to a temperature of boiling noticeably affected the hardness of the curds.

Hard curd milk could be converted into a soft curd product by homogenizing at 3000 to 5000 pounds. The author homogenized the milk at 120° F.

Experiments with rats failed to show that soft curd milk had an advantage over hard curd milk in producing normal development. J.C.M.

New Apparatus for Determining the Curd Character of Milk. A. P. COLE, Michigan State College, East Lansing, Mich. *Milk Plant Monthly*, 24, 1, p. 24, Jan., 1935.

The author describes a new curd tension apparatus by the use of which it was possible to secure results which did not exceed six per cent in variation as compared to about 17 per cent by other methods. The speed of the knife cutting through the coagulated milk is made uniform through hydraulic means. Illustrations are given.

The apparatus consists of a beaker, curd knife, metal plunger, and the measuring device proper. G.M.T.

Limitations of the Methylene Blue Test in Grading Milk. E. G. HASTINGS, Univ. of Wisconsin, Madison, Wis. *The Milk Dealer*, 24, 7, p. 72, April, 1935.

The author explains the factors affecting the reduction of methylene blue and concludes: "From our present knowledge it is believed that when the reduction time is in excess of eight hours the methylene blue test will not give, with sufficient accuracy for control work, the bacterial content of the milk examined." C.J.B.

Correlation of the Viscosities of Protein Solutions with Their Ability to Crystallize. DAVID B. HAND, Dept. of Physiol. and Biochem., Cornell Univ., Ithaca, N. Y. *J. Gen. Physiol.*, 18, p. 847, July, 1935.

Published values for the viscosity of different protein solutions at various concentrations were reduced to values at the same protein concentration, by means of the empirical formula of Kunitz (*J. Gen. Physiol.* 9: 717 and 10: 811). It was found that 1 per cent of crystallizable proteins have relative viscosities less than 1.060 while amorphous proteins have vis-

cosities greater than 1.085. Data are given for ten proteins. Casein is exceeded in viscosity only by gelatine. The author believes that variation of viscosity with pH and salt concentration is not sufficient to alter classification of proteins into crystallizable and amorphous proteins on the basis of viscosity.

B.L.H.

Presence of Yeasts in Fruit Juices that are Sold for Beverages. J. M. BRANNON, Univ. of Ill., Urbana, Ill., and R. J. POLLITT, Beatrice Dairy, Danville, Ill. *The Milk Dealer*, 25, 2, p. 35, Nov., 1935.

The authors call attention to the fact that while fruit juices (such as orange juice) contain very few bacteria, they do contain yeast, thereby necessitating that care be exercised in the handling and disposition of such fluid foods.

C.J.B.

Weigh Can vs. Single Can Samples for Bacterial Analysis. A. H. ROBERTSON, N. Y. State Dept. Agric. and Markets, Albany, N. Y. *The Milk Dealer*, 24, 3, p. 56, Dec., 1935.

A brief discussion of the methods of procuring milk samples for bacterial analysis is given. It is concluded that since the weigh can sample is more truly representative it is fairer to all concerned.

C.J.B.

Increasing Solids-Not-Fat. W. M. REGAN, Prof. of Animal Husbandry, Univ. of California, Davis, California. *Pacific Dairy Rev.*, 38, 8, p. 14, August, 1934.

Experiments were conducted at the California Experiment Station which showed that neither the turning of high producing cows to abundant alfalfa pasture nor the feeding of as much as 40 pounds of wet brewers' grains daily affected in the slightest the percentage of solids-not-fat in the milk which they produced.

Another experiment is being conducted to study the effect of feeding concentrates only. Cows are now in their second milking period that have never had any roughage during their lives. At the height of lactation some of these cows ate 25 pounds of concentrates daily. In all cases, their milk was normal for the breed in solids-not-fat.

Some dairymen and regulatory officials believe that the percentage of solids-not-fat in the milk can be influenced by the kind of food furnished the dairy cow, but it has been shown to be due to other factors—the individuality of the cow, her period of lactation, or to the season of the year.

It is possible for any dairyman to raise the average solids-not-fat content of the milk from his herd through one or all of three processes, as follows—he may add high solids cows, either of the same breed that he has already, or of a new breed; he may eliminate from his herd the cows

that are extremely low; and he may use herd sires selected from families noted for high solids-not-fat.

Committee comments: Families of cows within a given breed that are known to give high-solids milk are rare. J.C.P.

Detection of Mastitis Through Examination of Milk at the Dairy Plant.

E. G. HASTINGS, Dept. of Agr. Bact., Univ. of Wisconsin, Madison, Wisconsin. *Milk Dealer*, 23, 10, p. 46, July, 1934.

This paper, presented at the 1934 University of Wisconsin Dairy Manufacturers Short Course, discusses very briefly the laboratory methods which may be used to detect mastitis in milk. They are; examination of strainers for flocculent material, analysis of milk for chlorine content, microscopic examination, the catalase test, and examination of cultures of milk on various kinds of agar.

Tests should be made on the milk from individual cows and are of the greatest value when applied to the first few streams of milk drawn from each quarter of the udder. Young animals are likely to be free from udder infection; the older animals are likely to be infected.

There is no authentic data on the importance of the disease as a factor in reducing the production of the individual animal. It is not likely that milk from inflamed udders will produce sickness in man. The organism causing septic sore throat in man however, may produce a type of inflammation of the udder, and is of great sanitary significance.

While mastitis may not present a sanitary problem at present, it does present a problem to which the milk producers and distributors should give serious consideration. J.C.P.

A Study of the Effect of Removing Foremilk on the Fat Content of the Remainder of the Milking. H. E. ROSS AND HELMUTH WINTHER, Dept. of Dairy Industry, Cornell Univ., Ithaca, N. Y. *Cornell Univ. Exp. Sta. Bul.* 589, March, 1934.

This study was prompted by the demand of the metropolitan milk market that grade A milk contain not less than 3.5 per cent milkfat. Milk from 45 cows of the University herd was examined, representing six breeds. The cows varied in lactation period from one to twelve months. The number of streams of milk removed from different quarters of the udder varied, being 5, 10, 15 and in some cases 20. The Babcock test was used in determining the percentage of butterfat. The removal of foremilk from each quarter of the udder increased the fat content of the remainder of the milking, but it was necessary to remove a considerable portion of the foremilk to obtain an appreciable increase in the remainder.

In the case of the Holstein, removing 20 streams of the foremilk from each quarter raised the fat content of the remaining milk 0.17 per cent. The 20 streams represented almost 10.5 per cent of the entire milking.

P.H.T.

Commercial Production and Scientific Value of Soft Curd Milk Produced by Base Exchange Treatment. H. E. OTTING AND J. J. QUILLIGAN, M. and R. Dietetic Laboratories, Inc. Milk Dealer, 23, 11, p. 36, August, 1934.

This paper was presented at the annual meeting at the American Dairy Science Association, Ithaca, New York, June 26 to 28, 1934. The base exchange treatment, reported by Otting and others in 1933, allows a down-flow of milk to come into contact with a bed of Zeolite which rests on 50 mesh stainless steel cloth.

The following procedure is given:

"Raw milk of any degree of curd tension is placed in a vat acidified to 0.3 per cent as lactic with a 2N citric acid solution, preferably at a temperature below 50° F. to prevent curdling. The milk is then heated to 64° F. and, after removing air from the bed of Zeolite by up-flow treatment, the milk is allowed to pass down-flow through the Zeolite into another vat. At the present time 700 gallons of milk is passed through seven cubic feet of Zeolite in 1½ hours, the treated milk having an acidity of 0.15 per cent and the hydrogen ion concentration of 6.50. For the period of a year the bacterial counts have averaged about 5000 cc. as measured by the standard plate count."

This treatment produces milk of zero curd tension, as compared to the soft curd standard of 20 to 30 grams set by Hill at the Utah Agricultural Experiment Station. A modified Hill test was used to determine curd tension. Although there is a reduction in calcium and phosphorus, metabolism tests have shown that they are better utilized from base exchange milk, probably due to the presence of a double amount of ultrafilterable calcium as compared with regular milk. There is also a slight adjustment of the ash, its alkalinity increasing in base exchange milk.

This process produces milk differing very little in taste, appearance, and other qualities of regular milk. The cream line is practically the same as in pasteurized milk, and if disturbed after once formed, returns more quickly and thoroughly than in regular milk. Bacteria count averages several thousand less in pasteurized base exchange milk as compared to the same milk without treatment which may be due to a filtering out of bacteria when the milk passes through the Zeolite, or to a lowering of the heat resistance through a rearrangement of salts.

The authors predict, after noting the comments and observations of users and physicians, that base exchange milk has good market possibilities.
J.C.P.

Elimination of *Brucella abortus* with the Milk of "Carrier" Cows.

REDVERS THOMPSON, McGill University, Quebec, Canada. J. Inf. Diseases, 55, 1, p. 7, July-Aug., 1934.

Since the attempts to cure or immunize animals against infectious abortion have repeatedly failed, the disease must be considered in the same category as tuberculosis. If the organism, *Brucella abortus*, is pathogenic for man, the mode and extent of its elimination from its host are important questions for public health. Previous investigations have established that the organisms may be eliminated in the milk from infected animals. The present investigation deals with the isolation of *Brucella abortus* from "carrier" cows whose history gives no outward manifestations of infectious abortion and whose production of milk places them in the category of "high producers." From the dairyman's point of view he would have regarded these animals as healthy, high producing animals which were valuable to keep in the herd. Serologic tests however showed agglutinins for *Brucella abortus* in dilutions of 1:50 to 1:500. Further examinations revealed that ten such animals eliminated the organisms in their milk and hence should be classed as "carriers."

The author found that the inoculation of guinea pigs is slightly more efficient as a means of examining milk for *Brucella abortus* than the Petri plate method.
A.C.F.

II. Further Studies of the Influence of Different Levels of Fat Intake Upon Milk Secretion. L. A. MAYNARD, C. M. McCAY, H. H. WILLIAMS AND L. L. MADSEN, Cornell Univ. Agr. Exp. Station, Ithaca, N. Y. Cornell Agr. Exp. Sta. Bul., 593, April, 1934.

In studies with milking cows, 4 per cent fat level in the grain mixture has been compared with levels ranging between 6.5 and 7 per cent. No evidence was obtained that the level of fat intake has any influence on the percentage of fat in the milk.
P.H.T.

The Use of Chlorin Products as Germicides on Dairy Farms. W. G. LOVELESS, Dept. of Dairy Husb., Vt. Agr. Exp. Sta., Burlington, Vt. Vt. Agr. Exp. Sta. Bul. 369, April, 1934.

This bulletin gives information of special value in the use of chlorine solutions on the farm.
A.C.F.

Milk Contamination and the Methylene Blue Reduction Test. N. R. THORNTON, N. J. STRYNADKA, AND F. W. WOOD, Dept. of Dairying,

Univ. of Alberta, Canada, and C. ELLINGER, Dairy Supervisor, Board of Health, City of Edmonton, Alberta, Canada. *Can. Public Health J.* 25, 6, p. 284, 1934.

Experimental work was conducted to determine the comparative importance of the different sources of milk contamination on the farm in terms of the methylene blue reduction test.

Twenty farms were selected, the majority of which were having difficulty in maintaining the standard set by the city of Edmonton for milk shipped to milk plants for pasteurization. The regulation requires a minimum reduction period of 5.5 hours as indicated by the methylene blue reduction test.

Bacteriological surveys of the milk production methods showed that the only factors which, singly or in combination, were invariably the major cause of difficulty in maintaining the 5.5 hour standard were: (a) Utensil contamination, (b) Lack of adequate cooling of the milk, and (c) Pathological or abnormal milk.

The authors emphasize utensil contamination as the most important factor and state that there is need for a simple, efficient, and inexpensive method of applying disinfection to milk utensils on the farm. Data are presented to show that contamination from the utensils varies with the temperature at which the utensils were kept between milkings. Milk cans kept "indoors" (warm) were found to contaminate the milk to a much greater extent than those kept "outdoors" (cool). Inadequate cooling was the cause of poor quality in only 3 cases when night's milk was above 55° F. in the morning.

Under the conditions prevailing in the milk shed, the covered (small-top) milk pail was found to be a negligible factor in protecting milk from bacterial contamination.

The authors conclude that "while mastitis or other abnormal milk may cause the reduction of methylene blue in herd milk in 5.5 hours or less, this probably infrequently happens except under very careless herd management and in any case such milk should never be mixed with a city milk supply."

A.C.F.

The Value of the Recording Ultraviolet Meter in the Irradiation of Milk.

G. C. SUPPLEE, Bainbridge, N. Y., and H. C. RENTSCHLER, Bloomfield, N. J. *Medical Record* 142, Sept. 18 and Oct. 2, 1935.

The development has been announced of an ultra-violet ray recording meter for the accurate control of irradiation of milk. This instrument and its application were worked out by Dr. H. C. Rentschler of the Westinghouse research laboratories and Dr. G. C. Supplee of the Borden Company. It is a final step in checking the potency of irradiated milk during irradiation, thus determining immediately whether the efficiency of the process is up to standard. It is analogous in the principle of its application to the recording thermometer on a pasteurizer.

C.J.B.

Survey of Consumer Buying Habits Reveals Our Advertising, Sales Policies Need a "Shake-Up." P. O. NARVESON, Los Angeles, California. *The Milk Dealer*, 24, 8, p. 34, May, 1935.

A survey of the buying habits of fresh-milk consumers made through calls on 2,000 typical homes in 11 southern California districts indicates that consumers want richer milk, holding that feature more vital than many others that are more important. They also want better taste and flavor, which they seem to associate with raw milk.

The average consumer does not appreciate the dietary value and sanitary quality of milk. For cooking they use "canned milks," probably because it has been "sold" to them. In general the survey indicates that consumers regard for fresh milk is affected by advertising. They have heard about children's need for milk so they give it to the youngsters but don't use it themselves. They have a feeling that "natural" milk is best, probably from certified milk advertising and from childhood associations. C.J.B.

Iodized Milk and the Human Diet. ORMSBY MCHARG, I-O Products, Inc., Milwaukee, Wisconsin. *The Milk Dealer*, 24, 7, p. 76, April, 1935.

The article discusses the need of organic iodine in the human diet. Two ways of producing an iodine content in milk are discussed. The most desirable way, because it helps the cow and her offspring, is to incorporate an organic iodine in the cow's feed. The other way is to add the organic iodine to her milk while in the pasteurization tank, stirring the contents so as to insure a uniform mix.

Feeding enough organic iodine to cows with their dry feed or in their water supply will produce any desired number of parts of pure organic iodine per billion in their milk. Repeated tests where a five per cent organic iodine solution was fed to cows at the rate of one gallon to 10 tons of dry feed, and where the average cow has been fed 10 pounds of this dry feed per day, have produced in the milk an iodine content of approximately 900 parts per billion. Approximately 20 per cent of the iodine fed to cows recurs in their milk in pure organic form. C.J.B.

New Lactometers for Use in Routine Milk Analysis. DAVID WILBUR HORN, Bryn Mawr, Pa. *The Milk Dealer*, 24, 11, p. 33, August, 1935.

The author has introduced a rational lactometer (so-called for the lack of suggestion of a better name). Some unsuspected weaknesses of current forms of lactometers are brought out. A description is given of a modification of the rational lactometer enabling the operator to read total solids at once and to obtain solids-not-fat directly, by the use of the simplest mental arithmetic. C.J.B.

The Nutritive Value of Lactose in Man. ALFRED E. KOEHLER, IONE RAPP AND ELSIE HILL, Santa Barbara Cottage Hospital and the Sansum Clinic, Santa Barbara, California. *J. Nutrition* 9, p. 715, June, 1935.

The ingestion of 1.5 g. of lactose per kilo in normal subjects did not cause any marked change in the blood sugar level but lactosuria frequently resulted. In diabetics the ingestion of lactose caused a rise in blood sugar of nearly the same magnitude as did glucose, but lactosuria was not noted. Lactose ingestion caused a slight rise in the blood sugar of obese subjects. The average recovery, in the urine, of injected lactose was the same (89 to 93 per cent) in normal, diabetic, or obese subjects. Ingested lactose caused a small drop in blood inorganic phosphorus. L.A.M.

The Effects of Lactose on Growth and Longevity. E. O. WHITTIER, C. A. CARY AND N. R. ELLIS, Labs. and Animal Husbandry Div. Bur. of Animal Ind., U. S. Dept. of Agri., Washington, D. C. *J. of Nutrition* 9, p. 521, April, 1935.

With diets containing 30 per cent of lactose or of sucrose, the lactose diet caused more rapid increase in weight in young rats and a longer average life. With *ad libitum* feeding the animals on the sucrose diet became much heavier than those on the lactose diet, primarily because of a larger fat storage which was attributed to a larger food intake. Pigs fed sucrose accumulated a greater proportion of fat than did those fed lactose. The characteristic effect of lactose was evidently not due to stimulation of the growth of acidophilic organisms, since dextrin did not have the same effect as lactose. Diets containing 45.0 and 63.5 per cent of lactose caused diarrhea whereas similar levels of sucrose were tolerated. L.A.M.

Ultra-Violet Rays Now Go to Work in Dairies. L. V. BURTON, Editor of *Food Ind.*, McGraw-Hill Co., New York, N. Y. *Food Ind.*, 6, 8, p. 342, August, 1934.

A brief history of the discovery of the processes of producing vitamin D milk is given, the equipment for irradiating is described and illustrated, costs of production are considered, and some experiences in competitive distribution are discussed. J.C.P.

What Every Person Should Know About Milk. LESLIE C. FRANK, Sanitary Engineer in Charge, Office of Milk Investigations, U. S. Public Health Service, Washington, D. C. *Milk Dealer*, 23, 10, p. 86, July, 1934.

This is a general statement of the food value of milk. No new information is given, although quotations are included from some of the recognized authorities. The author predicts that some time in the future grade A milk

may be required to have been produced by cows receiving at least a standard balanced ration so their milk may possess the maximum food value for human beings. J.C.P.

The Influence of Vitamin D in the Prevention of Dental Caries. P. G. ANDERSON, C. H. M. WILLIAMS, H. HALDERSON, C. SUMMERFELDT, AND R. C. AGNEW. *Am. Dent. Assn.*, 21, p. 1349, Aug., 1934.

The influence of vitamin D on the incidence of dental caries was investigated by placing 87 children, from 2 to 16 years of age, on a diet containing vitamin D in the form of viosterol, and comparing them with 75 not receiving extra vitamin D. The regular diet of all the children consisted of milk, meat, vegetables, fruits and cereals. The vitamin D was incorporated in the form of 8 drops of 250 D viosterol in a ginger cookie. Results showed that the addition of this form of vitamin D brought about a striking decrease in dental caries in the children in the age group from 3 to 10 years, but that the reduction was not statistically significant in those from 11 to 16 years of age. The conclusion is that added vitamin D decreases dental caries in children living under good hygienic and dietetic conditions. J.A.T.

Effectiveness of Vitamin D in Infancy in Relation to the Vitamin Source. P. C. JEANS AND G. STEARNS. *Proc. Soc. Exp. Biol. and Med.* 31, p. 1159, 1934.

Studies on seven infants, three from 5 to 8 weeks of age, three from 16 to 24 weeks, and one a year old, show that the calcium retention per kilogram of body weight was about the same when each in turn was given formulas made from irradiated evaporated milk containing 50 Steenbock units of vitamin D, evaporated milk to which a concentrate of cod liver oil containing 150 units had been added, and evaporated milk supplemented with cod liver oil containing 40 units per gram.

Committee comments: The authors convey the idea that this article is a preliminary report. A.C.F.

Clinical Experience with Vitamin D Milks. J. M. LEWIS. *N. Y. State Jour. Med.* 34, p. 685, Aug. 1, 1934.

Investigations of the incidence of rickets show that from 50 to 60 per cent of infants in New York City display evidence of clinical rickets in the winter, and that in 10 per cent of the white and 20 per cent of the colored babies rickets is severe. Since milk is the universal food for infants, it is logical to enrich it in vitamin D, thus providing automatic protection against this widespread disease.

When Vitamin D milk is employed, a smaller number of units is required than in the case of other antirachitics. Irradiated milk is protective when

42 rat units of vitamin D are fed daily, whereas 600 units are needed when viosterol is used, and cod liver oil must furnish 160 units. Vitamin D milk from cows fed on irradiated yeast is effective in the control of rickets when 24 ounces containing 160 rat units per liter are given daily. These results have been shown by clinical tests on 202 infants, carried out by the author and the late Dr. A. F. Hess.

Milk containing 80 units of crystalline vitamin D, isolated from ergosterol, has also displayed marked antirachitic properties, but poorer results were achieved when this crystalline vitamin D was dissolved in oil, a fact proving again that milk is the ideal medium for vitamin D. J.A.T.

Infant Nutrition: Some Principles for Infants and Adults. J. R. GERSTLEY. *Ill. Med. J.*, 66, p. 280. Sept., 1934.

The addition of at least 12 per cent lactose to cow's milk for infant feeding results in a favorable change in the intestinal flora from a type in which colon bacillus predominates to a gram positive type in which bifidus acidophilus organisms predominate, as in breast fed infants. The stools are acid and resemble those of breast fed infants. About two weeks should be allowed for the change in intestinal flora to occur. The addition of suitable amounts of lactose to the adult diet will establish an intestinal flora favorable to the growth of acidophilus organisms and inhibitive to the putrefactive type. J.A.T.

Breast and Artificial Feeding. CLIFFORD G. GRULEE, Rush Medical College, Chicago, Illinois. HEYWORTH N. SANFORD, Infant Welfare Society, Chicago, Illinois. PAUL H. HERRON, Spokane, Washington. *J. Am. Med. Assoc.*, 103, 10, p. 735, Sept. 8, 1934.

In a study of 20,061 infants from birth to 9 months of age, 48.5 per cent were totally breast-fed, 43.0 per cent were partially breast-fed, and 8.5 per cent were artificially fed. The total morbidity of the breast-fed group was 37.4 per cent, of the partially breast-fed group 53.8 per cent, and of the artificially fed group 63.6 per cent.

The average mortality of these infants per year was 1.1 per cent. Of this mortality, 6.7 per cent were in the breast-fed group, 27.2 per cent in the partially breast-fed group, and 66.1 per cent in the artificially fed group.

A.C.F.

Producing Homogenized Vitamin D Milk. ARTHUR G. WEIGOLD, Manager, Torrington Creamery Inc., Torrington, Connecticut. *Milk Dealer*, 23, 12, p. 32, Sept., 1934.

The author relates his experiences in producing homogenized milk, the cost of which was found to be \$0.009 or nearly one per cent per quart for

depreciation, power, and labor. If a larger volume were handled, this cost would be reduced considerably.

During the past year the creamery has placed homogenized vitamin D milk on the market and has found it to be satisfactory, sales increasing from this type of milk each week. Several cases are cited where the homogenized milk was found to be very valuable in the feeding of infants. J.C.P.

Vitamin D in the Blood and Milk of Cows Fed Irradiated Yeast. R. F. LIGHT, L. T. WILSON AND C. N. FREY, Fleischman Laboratories, New York and Walker-Gordon Laboratory Co., Inc., Plainsboro, N. J. *J. Nutrition*, 8, 105, 1934.

The work of Sure (*J. Biol. Chem.* 76, 685, 1929) has shown that probably less than 30 per cent of the vitamin B ingested is secreted in the milk of rats. Fraps and Treichler (*Ind. and Eng. Chem.* 24, 1079, 1932) has shown that the vitamin A content of milk may range from 75 to 2000 units per quart depending upon the vitamin A content of the feed.

According to Hess *et al.* (*J. Biol. Chem.* 97, 369, 1932) the vitamin D potency of butterfat is inversely proportional to the per cent fat in the milk and nearly directly proportional to the amount of vitamin D fed.

The data presented in this paper indicate that practically all of the vitamin D ingested is absorbed in the blood stream although the major portion is destroyed in the body. The destruction is more rapid than heretofore suspected. The secretion of vitamin A and D respectively into milk is similar in that 2 to 3 per cent of the ingested vitamins is secreted into the milk. They differ however in that vitamin A appears to be more stable in the body and much of its excess is stored in the liver. G.E.H.

Storage of Vitamin A in Cattle. H. R. GUILBERT AND G. H. HART, Col. of Agr., Univ. of California, Davis, California. *J. Nutrition*, 8, 25, 1934.

In previous work Hart *et al.* have shown that cattle on the range in California are subject to a low vitamin intake during the dry season. Two steers on a ration of dried molasses beet pulp, rolled barley, cottonseed meal and calcium carbonate showed clinical symptoms of vitamin A deficiency. At 282 days of feeding they were in critical condition.

On restricted vitamin A diets the milk of the dams was deficient or subnormal in vitamin A. The calves from heifers having a restricted vitamin A diet during gestation developed a severe diarrhea at 2 to 8 days of age.

The manifestations of vitamin A deficiency under natural conditions on the range, previously reported, have thus been produced under controlled conditions. G.E.H.

MISCELLANEOUS

A Study of the Composition of Boiler Water. Parts I and II. J. L. BRAY, Purdue Univ., West Lafayette, Ind. *The Milk Dealer*, 24, 5, p. 32, Feb., 1935; No. 6, p. 40, March, 1935.

Part I. The writer feels safe in saying that over 90 per cent of the boiler failures with which he has been concerned can be traced to one cause—embrittlement of the metal and that in turn to the composition of the boiler water. Such a failure characteristically starts between rivets, usually on a longitudinal seam, although sometimes on a girth seam, as a hair-line crack.

When water of "temporary" hardness is brought to boiling, the carbonates precipitate out, may be removed, and thus render the water soft. When the hardness of the water is of a permanent character, there are available two methods of softening, the lime-soda process and the zeolite process. In the lime-soda process calcium hydroxide is used to remove calcium and magnesium carbonates and bicarbonates and soda ash to remove the sulphates. The calcium and magnesium are removed; only relatively small amounts of sodium sulphate and carbonate are present and these, after prolonged use of the boiler, tend to form an easily removed scale. In the zeolite method of softening, while the calcium and magnesium are removed, their places are taken by similar sodium salts or, strictly speaking, the calcium and magnesium are replaced, not removed.

Part II. The possible causes of boiler failure are listed as follows: (a) material, (b) workmanship, (c) condition of operation, and (d) character of boiler water. The author minimizes the first three causes but stresses the importance of character of boiler water. In the opinion of the author, particularly in hard-water districts, it is the most common reason for failure.

Tabulations of the composition of the feed waters used in boilers that have failed through embrittlement show a very low sodium sulphate to alkalinity-as-sodium carbonate ratio. Hard waters used in boilers which did not show embrittlement showed a relatively high ratio existing between these constituents. Laboratory tests showed that failure always occurred when the above ratio is low, seldom if ever occurred when it is high.

The necessity of keeping this ratio within certain limits is now recognized in the adoption of a boiler code by the American Society of Mechanical Engineers which calls for a definite relationship between this ratio and steam pressure, as follows:

ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

STEAM PRESSURE—LBS. PER SQUARE INCH	RELATION OF SODIUM CARBONATE ALKALINITY	TO SODIUM SULPHATE
0 to 150 ..	1	1
150 to 250 ..	1	2
250 and over ..	1	3

In using water of temporary hardness, as we add make-up water the carbonates of calcium and magnesium, together with some sulphates, precipitate out in the form of a light, fluffy, and easily removed scale. However, the salts of sodium are soluble and gradually build up in solution until the boiler water becomes very alkaline without the necessary sulphate to protect it. These are the very conditions for embrittlement. If zeolite softening is used, the same condition is brought about—the substitution of sodium salts for those of calcium and magnesium. Even with the lime-soda treatment the condition might come about, but much more slowly.

The following conclusions are drawn: 1. Watch the sodium sulphate to alkalinity-as-sodium carbonate ratio in boiler water. The composition of the feed water while significant is not vital, for it is the composition of the water that comes in contact with the boiler metal that is important. 2. Analyze the boiler water at regular and fairly frequent intervals and when the requisite ratio is exceeded take steps to adjust it either by suitable additions or blow out the boiler and start over. 3. Be careful in using waters of temporary hardness. While these may appear attractive from an operating standpoint and often are not harmful, the changes taking place in the boiler may bring about a very dangerous condition. 4. Either process of water softening may be used, for both possess certain advantages but must be accompanied by constant analyses to avoid building up harmful salts. 5. Avoid outside-caulked boilers and do not allow the repairmen to caulk leaky boilers from the outside. While this method of repair is easier and cheaper, it permits concentration to take place in the space between the plates of the seam. The safe ratio may not be exceeded in the main body of the boiler water, yet it may be exceeded in this confined space through evaporation and lack of circulation. Solid caustic has actually been found in such seams.

C.J.B.

The Common Refrigerants. J. S. Beamensderfer, York Ice Machinery Co., York, Pa. *Ind. Eng. Chem.*, 27, p. 1027, Sept., 1935.

A review of the characteristics and performance of the chemicals commonly used as refrigerants. The importance of a study of their properties in connection with compressor, condenser and evaporator design is emphasized. The chemicals discussed include carbon dioxide, ammonia, Freon, methyl chloride, sulfur dioxide, F-11, methylene chloride, and water.

J.H.N.

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ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

BUTTER

The Diketone Produced when Butter Cultures Are Steam Distilled with Ferric Chloride Added. B. W. HAMMER, Iowa State College, Ames, Iowa. *JOURNAL OF DAIRY SCIENCE* 18, 11, p. 769, Nov., 1935.

The data obtained indicate that the diketone steam distilled from butter cultures after the addition of ferric chloride is diacetyl rather than one of the homologues and that if homologues are present they are limited to relatively non-significant amounts.

B.W.H.

Substances Adsorbed on the Fat Globules in Cream and Their Relation to Churning. IV. Factors Influencing the Composition of the Adsorption "Membrane." CHARLES E. RIMPILA AND L. S. PALMER, Div. of Biochemistry, Univ. of Minnesota, St. Paul, Minnesota. *JOURNAL DAIRY SCIENCE* 18, 12, p. 827, Dec., 1935.

A study was made of the percentage of protein and of phospholipids, the phosphatase activity and the Van Slyke nitrogen distribution of the protein in the adsorption "membrane" of different samples of natural cream after successive washings of the cream with distilled water and of the percentage of protein and phospholipids and the Van Slyke nitrogen distribution of the adsorption "membrane" of artificial creams obtained from washed emulsions of butterfat in skim milk, buttermilk and sweet rennet-whey. The results show that the natural "membrane" is not derived from the components of milk plasma, but is a specific product having somewhat variable proportion of protein and phospholipids in different samples of natural cream but essentially the same proportion of major components in any one sample of cream after the fourth washing and at least through the tenth washing. A large part of the phosphatase activity of natural cream was found to reside in the "membrane" and was not removed by washing. The protein portion of all the "membranes" isolated from both natural and artificial creams was abnormally low in nitrogen, due apparently to a prosthetic group not yet identified.

L.S.P.

The Vitamin A Activity of Butter Produced by Cows Fed Alfalfa Hay and Soybean Hay Cut in Different Stages of Maturity. J. H. HILTON, S. M. HAUGE, AND J. W. WILBUR, Dept. of Dairy Husb., Pur-

due Univ., Agr. Exp. Sta., Lafayette, Indiana. JOURNAL DAIRY SCIENCE 18, 12, p. 795, Dec., 1935.

In a study to determine the relative vitamin A values of alfalfa and soybean hay cut in different stages of maturity and cured by different processes, it was found that hays made from younger plants were higher in vitamin A values than hays made from older plants, and that the artificially dried hays were superior to the corresponding field cured hays. When these hays were fed to dairy cows as the chief source of vitamin A the butter produced by the cows fed the respective hays possessed a vitamin A potency similar in relationship to that possessed by the hays.

J.H.H.

The Vitamin Activity and Carotene Content of Butterfat from Ayrshire, Guernsey, Holstein and Jersey Cows. T. S. SUTTON AND W. E. KRAUSS, Ohio Agr. Exp. Sta., Wooster, Ohio. Ohio Agr. Exp. Sta. Bimo. Bul. 21, 8, Jan.-Feb., 1936.

Samples of butterfat from comparable groups of Ayrshire, Guernsey, Holstein, and Jersey cows were prepared and assayed biologically for vitamin A potency. The Guernsey and Holstein fats were found to have approximately the same potency and both fats were significantly more potent than Ayrshire and Jersey fats. The potencies of the respective samples were not correlated with the carotene intakes per unit of fat produced.

Carotene determinations on the fats showed differences in the ability of the breeds to transfer feed carotene into milk carotene, as well as the effect of pasture feeding on carotene output. The carotene content of the milk fat of the breeds increased in the following order: Ayrshire, Holstein, Jersey, and Guernsey.

The lack of correlation between the carotene content of butterfat and the total vitamin A activity of such fat is thought to be due to inherent breed characteristics which regulate the degree of transformation of the food source of vitamin A (Carotene) into the colorless form in the process of milk fat formation.

Some discussion is devoted to speculation as to the vitamin A activity per quart of standardized and unstandardized market milk of the various breeds. It is pointed out, however, that any discrimination between breed milks on this basis alone is at the present time questionable.

W.E.K.

The Acidity of Butter. EUGENJUSZ PIJANOWSKI. Polish Agr. Forestal Ann. 34, p. 349 (p. 399 in English), 1935.

In order to find a correlation between the acid test of butter and the acidity of its plasma, 36 samples of fresh creamery butter from different

plants were examined for acidity by taste and the acidity of butter plasma was determined by direct titration and from the following formula: $K_2 = \frac{100 K - K_1 t}{100 - t} - 1.8$ where K = total acidity of butter, K_1 = acidity of butter fat and t fat content of butter. In addition, water, curd, casein, lactic acid (by aldehyde method) and pH value (electrometrically) were determined and stained microscopical preparations of all samples were made. The results are summarized: A fair correlation ($r = 0.77$) existed between the acid taste of butter and the acidity of its plasma as measured chemically. The acid taste of sour butter seemed to be closely connected with the acid smell of butter. A high correlation was found between the acid taste and percentage of lactic acid in butter ($r = 0.72$), between the total acidity of butter and the acidity of butter fat ($r = 0.73$) and between pH of plasma and percentage of lactic acid ($r = 0.80$). No correlation was found between the acid taste of butter and the acidity of butter fat. Diplococci, seldom streptococci, were found in stained preparations and the major part of butter was contaminated with yeasts and mold cells even though negative to the Storch test.

J.K.

Differences in the Lactic Acid Percentages in Butters. E. O. WHITTIER AND C. S. TRIMBLE, Bur. of Dairy Ind., U. S. Dept. of Agr., Washington, D. C. Ind. Eng. Chem., Anal. Ed., 7, p. 489, Nov., 1935.

The quantity of free or combined lactic acid in butter may serve as a suitable index to determine if the product has been made from sweet or sour cream.

Published analytical methods depending upon removal of protein and carbohydrates, are tedious in application, and are subject to errors of 3 to 15 per cent. The authors have developed a method which avoids any preliminary treatment of the butter. Ten, twenty or thirty g. (depending on the percentage of lactic acid present) are weighed directly into a 300 c.c. Kjeldahl flask and the lactic acid and lactates are oxidized to acetaldehyde by the technique of Friedemann, Cotonio and Shaffer (J. Biol. Chem., 73, 335, 1927). The aldehyde is absorbed in sodium bisulfite solution with which it forms a compound. The excess of bisulfite is oxidized with standard 0.1 N iodine solution, after which the bound sulfite is liberated with alkali and titrated with 0.01 N iodine solution. A determination can be made in approximately twenty minutes with an accuracy of 97 per cent or greater.

After preliminary determinations on sixteen commercial samples of butter, the authors prepared forty samples of butter from two lots of cream, each lot being subdivided and given various treatments before and after churning. Each sample was analyzed for apparent lactic acid by the method described. Results ranged between 0.013 and 0.262 per cent. Twenty commercial samples of butter, four of which were churned from sweet cream,

were obtained from Southern creameries and analyzed. The sweet cream butters showed consistently less than 0.025 per cent of apparent lactic acid; the partially neutralized samples, consistently more than 0.05 per cent. Examination of sweet-cream butter before and after storage demonstrated that lactic acid does not develop in appreciable quantities even during long storage periods.

The authors conclude that butter made from normal sweet cream containing less than 0.25 per cent of titratable acid will contain less than 0.025 per cent of apparent lactic acid, while that made from normal sour cream containing more than 0.40 per cent acid will contain more than 0.100 per cent of apparent lactic acid. If sour cream be neutralized to approximately 0.20 per cent acidity, butter made from it will contain more than 0.05 per cent of apparent lactic acid.

J.H.N.

Keeping Cream Cool in the Cream Station. E. L. FOUTS, Oklahoma A. and M. College, Stillwater, Oklahoma. *Nat. Butter and Cheese J.* 26, 14, p. 14, July 25, 1935.

The Dairy Department of Oklahoma A. and M. College has found that an inexpensive way to cool cream for buttermaking is to stack the burlap wrapped cream cans into piles two cans high and keep a very fine spray of water, just enough to keep the burlap damp, directed over the cans. Evaporation of the water holds the cream at around 75° F. The highest cost is about one cent per 10 cans for a 24 hour period.

W.V.P.

XVII. A Study of Seasonal Variation in Butterfat. II. A Seasonal Spectroscopic Variation in the Fatty Acid Fraction. ROLAND BOOTH, STANISLAW K. KON, WILLIAM DANN, AND THOMAS MOORE, Nutrition Lab., Univ. of Cambridge, England, and National Inst. for Research, Univ. of Reading, England. *Biochem. J.* 29, 133, 1935.

Seasonal variations in the carotin and vitamin A contents of butterfat are well known. A method for determining the vitamin A value of butterfat involves the use of antimony trichloride. It is also known that there is a seasonal variation in the power of butterfat to inhibit the reaction between vitamin A and antimony chloride. Examination of 15 samples of butter covering 13 months shows a variation in the intensity of absorption at 230 mμ ranging from (April, 1933) $E \frac{1 \text{ per cent}}{1 \text{ c.m.}} = 8.4$ to (May, 1934) $E \frac{1 \text{ per cent}}{1 \text{ c.m.}} = 250$ when cows had access to pasture. The increase in absorption runs approximately parallel with the increased inhibitory power of the butterfat in the antimony trichloride reaction for vitamin A. However, the sub-

stances responsible for the inhibitory power are more sensitive to oxidation and irradiation than those responsible for 230 m μ absorption. Other factors, such as unrecognized acids or modified forms of known unsaturated acids with high extinction coefficient may be responsible for the increased absorption of summer butterfat.

K.G.W.

Contribution to the Study of Diacetyl. JEAN PIEN, JACQUES BAISSÉ AND ROBERT MARTIN. *Le Lait* 16, p. 119 and p. 243, 1936.

The most satisfactory method of preparing diacetyl was found to be the treatment of ethyl methyl ketone with amyl nitrite to yield the nitroso derivative. By the action of dilute soda on this substance, isonitrosoethyl methyl ketone was formed. The isonitrosoethyl methyl ketone was then freed from contaminating substances, isolated, and water and dilute sulphuric acid added to it. Diacetyl was finally obtained by steam distillation from this mixture. The diacetyl separates in an upper layer in the steam distillate. By redistillation over calcium chloride practically pure diacetyl can be obtained.

The use of hydroxyl amine and nickel salts in determining diacetyl as the nickel dimethylglycosimate was considered a satisfactory qualitative test but was considered inaccurate for the quantitative estimation of diacetyl. Another qualitative test for diacetyl was found in the condensation of two molecules of diacetyl to yield the cyclic compound, xyloquinone. On adding a pellet of caustic potash to the diacetyl solution a yellowish brown color of the xyloquinone appeared. The appearance of this color on adding caustic potash is not a specific test for diacetyl but as tests for diacetyl are usually made on distillates and relatively purified solutions the use of this very rapid method serves as a convenient test—at least as a test for the absence or possible presence of diacetyl. Diacetyl may also be determined qualitatively and characterized by its reaction with phenyl-hydrazine. In the cold, diacetyl reacts readily with phenyl-hydrazine to yield diacetylphenylhydrazone. The crystals of this compound exist in the shape of crosses of St. Andrew and serve better to identify diacetyl than do the crystals of diacetylphenylosazone which are obtained when diacetyl is heated on the water bath with an excess of phenylhydrazine. The most acceptable procedure for the quantitative determination of diacetyl was based on the reaction of diacetyl with compounds of the orthodiamino benzene type. Actually it was found more convenient to use meta-para-toluylene-diamine instead of diamino benzene. The diamine used was prepared by treating para-toluidine with acetic anhydride (the acetylation, of course, being for the purpose of protecting the first amino group while the second was being introduced). The acetylated toluidine was then treated with nitric acid which allowed introduction of the NO₂ group. On heating with caustic potash the original

amino group was restored and on reducing with hydrochloric acid in the presence of granular tin, the NO_2 group was reduced and the diamino compound is formed. This reagent is used for determining diacetyl in the following manner:

About 10 cc. of the solution to be tested is placed in a test tube and 5 cc. of an aqueous solution of 1 per cent metaparatoluylenediamine is added. After shaking, 10 cc. of concentrated sulphuric acid is carefully added, placing the pipette against the wall of the tube. There then develops the yellow color of the quinoxaline compound. The maximum color develops after the solution has stood for about one hour.

One part per 100,000 of diacetyl can be detected by this test but the test is best carried out on solutions containing diacetyl in amounts ranging between 1 to 5,000 and 1 to 10,000. Permanent standards for determining diacetyl may be prepared with potassium bichromate dissolved in water. The quantitative procedure which has been described was applied to the determination of diacetyl in a number of dairy products such as milk, cultured milks, butter, cream, etc. It was found that the quantity of diacetyl contained in these products was very low. Thus butter never contained more than 5 milligrams of diacetyl per kilo. The usual lactic starters contained as a rule less than 1 milligram of diacetyl per liter. Cream even when held for several weeks did not contain more than 1.5 milligrams per liter. Some butters, milks and creams contained no diacetyl at all. However, the authors believe that in spite of these low values for diacetyl that diacetyl may be important in contributing to the flavor and aroma of butter because only small amounts of diacetyl are required to produce a very noticeable aroma and because of the much higher acetyl methyl carbinol content of dairy products which therefore may serve as a continual reservoir to supply diacetyl. The possibility that methyl glyoxal may contribute to the flavor and odor of dairy products is also suggested. The authors are in accord with the French law of July, 1935, which prohibits the addition of diacetyl to dairy products. However, they believe that research should be continued on the substance to the end of gaining a better understanding of the part it plays in fermentation and in contributing to the aroma of dairy products.

A.H.J.

Bacteriological Analysis of Butter from the Region of Brest. Biology of the Typhoid Bacillus in Butter. J. BRISOU, Doctor of Science of the University of Bordeaux. *Le Lait* 15, p. 864, 1935.

About 5 grams of butter are first emulsified in 15 cc. of sterile bile. Five cc. of the bile-butter emulsion are then added to a flask containing 50 cc. of physiological salt solution, 50 cc. of 6 per cent peptone solution, and 2 cc. of malachite green (1 to 200). The flask and contents are then incubated at 37°C . for 24 to 36 hours (or a shorter period if the medium decolorizes too

rapidly). After incubation, the material is inoculated on freshly prepared lead acetate-agar plates. After growth on this media the colonies are identified in the usual way. The vitality of the organisms in butter was studied and considered to be related to the pH and not the free acidity. At pH values below 6, the vitality was reduced.

A.H.J.

Butter Improvers Based on Diacetyl—Are They Natural Products?

M. LEMOIGNE AND P. MONGUILLON. *Le Lait* 16, p. 26, 1936.

Just as with 2, 3 butyleneglycol and with acetylmethylcarbinol, diacetyl is a normal product of the metabolism of living organisms but the latter is found only in traces in biological fluids or bacterial cultures. Actually the presence of 1.5 to 2 grams of diacetyl per liter inhibited or destroyed the group of bacteria on which it was tested. It therefore appears that the group of butter improvers on the market containing 5 to 7 grams of diacetyl per liter cannot be considered as natural products.

A.H.J.

Chemical Study of Butter. R. VIVARIO AND G. VAN BENEDEN. *Le Lait* 16, p. 113, 1936.

Butters were characterized by their contents of four groups of fatty acids which have been classified as follows: the acids of low molecular weight such as butyric and caproic, the acids of average molecular weight (caprylic, capric, lauric, and myristic), unsaturated fatty acids (oleic), and the acids of high molecular weight (palmitic and stearic). Rapid methods of determining and calculating the four groups of fatty acids are given. Results obtained on three butters show that when the content of acids of average molecular weight was high, the content of acids of high molecular weight was low. Moreover the sum of these two groups of acids varied inversely with the oleic acid content. The content of acids of low molecular weight varied in the same way as the oleic acid content.

A.H.J.

Methods of Cooling and Storing Cream for Oregon's Dairy Farms: Influence on the Quality of Butter which Can be Manufactured. G. H. WILSTER, H. HOFFMAN, AND P. M. BRANDT, Dairy Dept., Oregon Agr. Exp. Sta., Corvallis, Oregon. *Oregon Agr. Exp. Sta. Bul.* 326, June, 1934.

This study was undertaken to determine the conditions under which cream could be kept on farms in order that 92-score butter could be made from it at the creameries.

Of the various methods studied, that of placing a five gallon can of cream with an initial temperature of 90° F. in a tank of flowing water having a temperature ranging from 47° to 54° F. was the most satisfactory for maintaining the quality of the cream. The score of butter made from such cream stored for 72 hours scored two points higher than that made from cream cooled by and stored in air at 44° to 86° F. with the mean daily temperature ranged from 53° to 77° F. It also averaged one point higher than the score of butter made from cream cooled and stored in a tank of still water which was changed twice daily and which had an initial temperature of from 47° to 60° F. Quick cooling of cream with water with an initial temperature of 47° to 60° F. followed by storing at air temperature, maintained the flavor better than cooling and storing at air temperature. Precooling in the above manner followed by storage in either still or running water was of no additional benefit.

The scores of butter that could be made from cream cooled and stored in different ways are given in the bulletin.

G.H.W.

How Can I Increase My Profits and Pay More for Butterfat? (No author given.) *Nat. Butter and Cheese J.* 26, 14, p. 20, July 25, 1935.

A discussion dealing with increasing dairy plant profits by purchasing cream on a grade basis, increasing the quality of the product, improving production efficiency and direct marketing.

W.V.P.

CHEESE

Bel-Paese Type Cheese. FRED KOPP AND GEORGE F. JACKSON, Univ. of Calif., Davis, Calif. *The Pacific Dairy Rev.* 39, 5, p. 14, May, 1935.

For approximately fifteen years the firm of Galbani Brothers of Melzo, Italy, has placed upon the market a cheese under the trade name of Bel-Paese. This cheese has gained great popularity not only in Italy but in southern and central Europe as well. It was observed that the Italian population of California demanded the cheese and it was believed that a similar cheese could be made in that state. The first mentioned author had the opportunity to observe the manufacturing and curing process of this cheese in Italy, and was able to produce a cheese which compared favorably to the imported product. The method of manufacturing and curing consisted of setting the highest quality of whole cow's milk obtainable at a temperature of 106 to 110° F. with rennet extract so that it would set in approximately fifteen minutes. The use of cone-shaped cans of 400 to 600 pound capacity was common practice.

When fairly firm the curd is cut crosswise with a long knife and reduced to the size of hazel nuts by the use of the scoop. At this point the curd is

wity put in a vertical revolving motion by means of an agitator. This is continued from six to eight minutes, after which the whey is drawn off the level of the settled curd. The curd is dipped into perforated metal hoops $7\frac{1}{2}$ inches in diameter by $7\frac{1}{2}$ inches high which rested upon reed mats.

A temperature of 80 to 86° F. is maintained for a period of $5\frac{1}{2}$ to 7 hours while the cheese is draining. To obtain satisfactory rind the cheese should be turned at least three times while draining. The hoops are removed and cheese placed in 17 per cent salt brine solution at 60° F. for a period of 6 to 10 hours. The cheese are placed on shelves in the curing room at 45° F. with relative humidity of from 88 to 92 per cent for 6 weeks with good circulation of air in room. Early in the curing period the surfaces of the cheese are colored a light yellow color and are washed and turned every other day.

The cheeses are wrapped either in waxed paper or aluminum foil and packed individually in wooden boxes. Packed in this manner they may be stored for four weeks at low temperature. The cheese produced compared favorably in chemical composition as well as in flavor and texture with the imported cheese.

P.A.D.

Moldiness in Romano Cheese. F. W. FABIAN AND J. W. SEVERNS, Dept. of Bact. and Hygiene, Mich. State College, East Lansing, Michigan. JOURNAL DAIRY SCIENCE 18, 11, p. 773, 1935.

A factory manufacturing Cacio Pecorino cheese, more commonly known as Romano cheese, from cows' milk reported that they were having considerable trouble with mold developing in the center of many of the cheeses. Upon investigation, it was found that it was the practice at this factory to punch the cheeses full of holes to facilitate the penetration of the 30 salometer brine in which they were soaked for about 3 days prior to ripening. This permitted the entrance and growth of molds. The mold isolated and identified from the samples of cheese submitted was *Pencillium italicum*. Chemical determinations for NaCl and moisture in different portions of the cheese indicated that the moisture content of the cheese would have to be approximately 25 per cent and the salt content not greater than 6 per cent to permit mold growth to take place.

F.W.F.

Future of the Industry Depends on Satisfying the Consumer. C. R. BARKER. Nat. Butter and Cheese J. 26, 14, p. 26, July 25, 1935.

The most important consideration in the production of cheese is to please the ultimate consumer with quality, price and service. This can best be done by making better cheese, by a system of critical grading and by standardizing quality to suit the market.

W.V.P.

Studies on the Manufacture of Trappist Type Cheese. J. C. MARQUARDT, N. Y. Agr. Exp. Station, Geneva, N. Y. N. Y. Agr. Exp. Sta. Bul. No. 662, Jan., 1936.

In this publication the author gives a brief review of the history of s hard cheeses of this type. The publication includes methods for making the natural and blended cheeses. There is also included a table of analyses of cheeses of this type taken from the work of the author and others.

The author concludes that a saturated humidity and a curing room temperance of 60° F. or below are essential to properly cure the cheese. Moistures from 40–45 per cent and salts ranging in percentage from 1.0 to 2.5 produced good cheeses.

Trappist cheese can be made by several methods that vary in detail but fundamentally not in principle.

Fading flavor, gritty cheese, and bitter flavor are common defects of cheeses of the Trappist type. J.C.M.

Sweet-Curd Cottage Cheese (Directions for Manufacturing with an Enzyme). P. H. TRACY AND H. A. RUEHE, Univ. of Ill., Urbana, Illinois. Ill. Agr. Exp. Sta. Cir. 445, Jan., 1936.

Factors relating to the quality of sweet-curd cottage cheese are listed and discussed. The methods for making sweet-curd cottage cheese, (1) a sixteen-hour and (2) a five-hour method, are described and causes of common body defects are given. O.R.O.

Cottage Cheese. JULIA NORWOOD, Modern Science Institute, Toledo, Ohio. The Milk Dealer 25, 6, p. 38, March, 1936.

The author discusses the origin of the name and the food value of cottage cheese. Several recipes are given for using cottage cheese. C.J.B.

Experiments Relating to the Manufacture of "Port-Salut" Using Pasteurized Milk Inoculated with Lactic Organisms. CH. PORCHER AND G. THIEULIN. Le Lait 15, p. 19, 1935.

Pasteurization of milk for cheese making has not only the advantage of destroying undesirable organisms but also the disadvantage of destroying desirable acid-producing organisms. The use of lactic organisms is discussed in relation to the production of the desired acid content for proper curdling of the casein. Preliminary experiments are described using carbon dioxide, carbon dioxide plus calcium chloride, and calcium chloride as aids in producing the proper type of curd and the desired consistency in the finished cheese. A.H.J.

Vegetable Rennin. Extraction and Properties. C. CHRISTEN AND E. VIRASORO. Le Lait 15, p. 354, p. 496, 1935.

A plant enzyme having a strong coagulating effect on milk was prepared from thistle flowers. One hundred grams of the dry flowers were extracted

with petroleum ether and then washed on a filter paper with ether. After evaporation of the ether, the material was ground to a powder and the powder extracted with 500 cc of 20 per cent ethyl alcohol. Filtration under vacuo yielded a clear, caramel-colored liquid of pH 4.7–4.8 which had a coagulating activity of 1:800. This preparation was stable for about 40 days when it became cloudy and molds began to develop. On evaporating the fresh extract to dryness a water-soluble caramel-colored residue equivalent to 6 per cent of the extract was obtained. The residue had an activity of 1:13,000. On increasing the alcohol content of the extract to 75 per cent, a precipitate of activity 1:36,000 was obtained. The total precipitate, however, had a coagulating power equivalent to only about one-fifth of that of the total extract from which it was prepared. The optimum temperature for the activity of this vegetable rennin was 68 per cent. Freezing the enzyme preparation operated to increase slightly the activity of the enzyme. Exposure to sunlight or to ultra-violet light had no effect on the activity of this plant rennin but such exposure reduced considerably the activity of animal rennin. This enzyme was used in making Camembert cheese and it was suggested that it might replace animal rennin without disadvantage in the making of most types of cheese. A.H.J.

The Pasteurization of Milk Intended for the Manufacture of Cheese.

JEAN PIEN. *Le Lait* 15, p. 748, 1935.

The compulsory pasteurization of milk to be used for cheese making is not to be recommended at the present time because of the difficulties experienced in inducing the proper curdling of pasteurized milk, definite types of curdling being necessary in producing certain types of cheese. A.H.J.

The Bacteriology of Swiss Cheese. IV. Effect of Temperature upon Bacterial Activity and Drainage in the Press. L. A. BURKEY, G. P. SANDERS, AND K. J. MATHESON, Bureau of Dairy Ind., U. S. Dept. of Agr., Washington, D. C. *JOURNAL DAIRY SCIENCE* 18, 11, p. 719, 1935.

Temperature, pH, and bacterial counts made at regular intervals and at definite distances from the hoop edge toward the center of 55-pound laboratory and large factory cheeses show that cooling occurs rapidly in the outer 1-inch area, becoming less rapid toward the center, the interior reaching 36° to 46° C. in 21 hours, depending on the size of cheese and the room temperature; that bacterial growth and acid production increases in general with the decrease in temperature of each part of the cheese; and that while most starter bacteria begin to increase in numbers near the outer edge during the first few hours, the initiation of growth in the interior occurs with *S. thermophilus* (C₈) within 2 or 3 hours, while *L. bulgaricus* (Ga and 39aH) after 5 or 6 hours, and with *L. helveticus* (39a) not until 9 or 10 hours after dipping. Large differences in pH between the interior and the area near the rind

result in insufficient drainage, and may cause such defects as checking near the rind and "glass." A sample of cheese for analysis in order to be representative of the interior should be obtained at least 4 inches from the hoop edge. The proper use of starters, especially an active *S. thermophilus*, facilitates early expression of whey from the interior and aids in the uniform drainage of the cheese.

L.A.B.

Camosum Cheese. N. S. GOLDING, State College of Washington, Pullman, Wash. Wash. Exp. Sta. Bul. 175 (Reprint), 1934.

The author fully describes a process for making a cheese for local marketing or home use, which is simple to make, requires a minimum of time, and inexpensive utensils. The process is based on the stirred curd principle, uses brine salting, and the cheese requires from one to three months to ripen.

N.S.G.

CONCENTRATED AND DRY MILKS

The Age Thickening of Sweetened Condensed Milk. V. C. STERNITZ AND H. H. SOMMER, Dept. of Dairy Industry, Univ. of Wisconsin, Madison, Wis. JOURNAL DAIRY SCIENCE 18, 11, p. 757, 1935.

The period of the year during which there is a tendency for sweetened condensed milk to thicken abnormally fast during storage was found to begin very abruptly and to occur any time from the middle of April to the middle of May in the territory of Madison, Wisconsin. The change back from unstable to stable milk occurred more slowly and took place during the latter part of June and July. This unstable period could not be correlated directly with the freshening of the cows or the time at which they were turned out on grass. The experimental vacuum pan for condensing the milk and the vacuum tube arrangement for measuring the viscosity of the condensed milk by the falling sphere method are described.

V.C.S.

The Age Thickening of Sweetened Condensed Milk. II. The Effect of Forewarming Conditions. V. C. STEBNITZ AND H. H. SOMMER, Dept. of Dairy Industry, Univ. of Wisconsin, Madison, Wisconsin. JOURNAL DAIRY SCIENCE 18, 12, p. 804, 1935.

Forewarming conditions exert a marked influence on the subsequent age thickening of sweetened condensed milk. Forewarming temperatures of 150 and 165° F. make a product which thickens less rapidly than heating the milk to only 135° F. With temperatures from 180° F. up to boiling the milk becomes considerably more unstable, while temperatures above boiling again make the milk less susceptible to age thickening.

Prolonged holding periods at the forewarming temperature tend to unstabilize stable milk, but have a slight effect in stabilizing unstable milk.

Having the sucrose in contact with the milk during forewarming has the greatest effect in causing the milk to thicken during storage, while having the sucrose in contact with the milk only during condensing at a temperature of 131° F. greatly decreases the viscosity, but makes a more viscous product than adding the sucrose as a syrup near the end of the condensing period.

Excessive age thickening may be prevented by withholding the sucrose during the time that the milk is at forewarming temperature. V.C.S.

The Age Thickening of Sweetened Condensed Milk. III. Effect of Reaction and Changes in the Electrical Conductivity during Manufacture and Aging. V. C. STEBNITZ AND H. H. SOMMER, Dept. of Dairy Ind., Univ. of Wisconsin, Madison. *JOURNAL DAIRY SCIENCE* 19, 1, 55, Jan., 1936.

The addition of two to four ounces of sodium bicarbonate to 1000 pounds of the raw milk before concentration materially reduced the thickening of condensed milk during aging. A.C.D.

Irradiated Evaporated Milk: The Transmission and Antirachitic Activation of Evaporated Milk Films by Ultra-violet Radiations. G. C. SUPPLEE, R. C. BENDER, G. E. FLANIGAN, M. J. DORCAS, AND C. E. GREIDER, The Dry Milk Co., Rsh. Lab., Bainbridge, N. Y., and National Carbon Co., Inc., Cleveland, Ohio. *JOURNAL DAIRY SCIENCE* 19, 1, p. 67, 1936.

Films of evaporated milk tend to be more dense than films of milk so that the influence of irradiation is less in increasing the vitamin D potency. A.C.D.

The Effect of Process of Manufacture on the Vitamin G Content of Dried Skimmilk. H. J. DAVIS AND L. C. NORRIS, Cornell Univ., Ithaca, N. Y. *JOURNAL DAIRY SCIENCE* 19, 1, p. 1, Jan., 1936.

There was no significant destruction of the growth-promoting component of the vitamin G complex in skimmilk when dried by the spray or open-roll process. A.C.D.

Determination of Lactose in Mixed Feed. D. A. MAGRAW AND C. W. SIEVERT, American Dry Milk Institute, Chicago, Ill. *Ind. Eng. Chem., Anal. Ed.*, 7, p. 106, March, 1935.

A method for the quantitative determination of lactose in mixed feed has been developed and shown to be accurate to ± 0.25 per cent. Reducing sugars which are not fermentable by ordinary yeast are usually present and must be changed by enzymes to a fermentable form without an accompanying change in the lactose present.

16.25 g. of the feed are extracted with 100 cc. of ethyl ether to remove fat. The residue is digested with water on a water bath for 30 min. and made up to a volume of 300 cc. After centrifugalizing, 150 cc. of the clear solution is transferred to a 200 cc. flask, 100 mg. of animal diastase, 75 mgm. of invertase-melibiose scales, and 1.5–2 g. of baker's yeast are added and fermentation carried out for 40–48 hours at 24.4° to 26.7° C. (76°–80°F.). The solution is made up to volume and centrifugalized, 190 cc. of the same then concentrated to 25–30 cc. by boiling, transferred to a 100 cc. flask with the aid of hot distilled water, treated with 10 cc. of saturated neutral lead acetate and completed to volume. After another centrifugal clarification 50 cc. of the clear solution is placed in a 100 cc. flask, treated with 2.5 cc. of a 5 per cent solution of mercuric chloride, let stand for 20–30 minutes with repeated shakings, 5 cc. of a 20 per cent phosphotungstic acid solution added, distilled water added to complete the volume, and the liquid again centrifugalized.

If not clear, the solution must be filtered through a dry paper, after which it is saturated with hydrogen sulfide and the precipitate filtered off. Fifty cc. of the clear solution are pipetted into a 300 cc. Erlenmeyer flask and boiled to get rid of the hydrogen sulfide. This solution is brought up to a volume of 50 cc. in a volumetric flask and lactose determined by the Munson and Walker method. Jena fritted-glass filtering crucibles I. G. 4 are recommended for collecting the copper oxide. The weight of reduced copper should be checked by solution of the oxide with 5 cc. of 1 to 1 nitric acid, followed by the application of the volumetric sodium thiosulfate method for copper. The corresponding weight of lactose is obtained from the Munson and Walker table.

The following formula is used to calculate the weight of dry material in the aliquot taken:

$$\frac{150}{(300-8)} \times \frac{190}{200} \times \frac{50}{100} \times \frac{5}{(100-1)} \times 16.25 = 2.003 \text{ g.}$$

To obtain the percentage of lactose in the feed, the following formula is applied:

$\frac{(X - 0.005)}{0.90 \times 2} \times 100$ where X = grams of lactose found, 0.005 is blank correction, 0.90 is the lactose factor for fermentation loss, and 2 is the weight of dry material taken (0.003 dropped as well within the experimental limit).

The percentage of lactose multiplied by 2 gives the percentage of dry skim milk in the feed mixture. If dried buttermilk is the dairy product used, then the percentage of lactose must be multiplied by 2.775 to obtain the percentage of dried buttermilk. Such calculations are possible only when the exact type of dairy product used in the feed is known.

Determinations of lactose in a number of samples of feeds known to contain dry skim milk are given and indicate that the method is reliable and

accurate to 0.25 per cent of lactose. While tedious, the technique is simple, with the temperature of fermentation the only condition demanding close control. The presence of molasses in the feed causes an error due to non-fermentable "glucose." Five per cent of molasses causes an increase of 0.2 per cent in the amount of lactose found in the sample. J.H.N.

Raising Dairy Calves with Dried Skimmilk. J. C. KNOTT, R. E. HODGSON, AND E. V. ELLINGTON, Washington State College, Pullman, Washington. Agr. Exp. Sta. Bul. 273, 1932.

The authors conducted experiments to determine if dairy calves could be raised on hay, water and a dry calf meal containing dried skimmilk, when no other milk was fed after six weeks of age. The calves were fed two weeks on whole milk; from the second to the third week they were changed to remade skimmilk, and from the fifth to the sixth week they were changed to no further liquid milk. The calves raised by this system were thrifty and vigorous at six months of age, and in no way distinguishable from heifers raised in the usual way on separated skimmilk.

The authors conclude that the system of raising dairy heifers as used in this experiment can be successfully used by dairymen where liquid skimmilk is not available.

In areas where whole milk is sold, this system materially reduces the cost of raising calves.

Feeding the dried skimmilk in the grain mixture reduces the labor required for feeding calves.

The economics of feeding dried skimmilk is fully discussed. At a value of 5 cents per pound for dried skimmilk the average cost of feeding a Holstein heifer was \$20.02 to six months of age; during which time an average of 151.5 pounds of dried skimmilk was fed each calf. N.S.G.

Practical Apparatus for Determining the Fatty Material in Rennet Casein. J. DELORME. *Le Lait* 15, p. 36, 1935.

To 10 grams of pulverized casein are added 20 cc. of concentrated hydrochloric acid. These materials are slowly heated to slight boiling until the casein dissolves. Gentle boiling is continued for 20 minutes in order to liberate the fat. After cooling, 50 cc. of water are added and the fatty material is extracted by shaking with 55 cc. of ethyl ether. An ether layer forms after standing for two hours. This ether layer is drawn off, the ether evaporated and the fatty matter weighed. An extraction apparatus is shown in which the dissolving of the casein and the extraction of the fat is conducted.

A.H.J.

Remarks on an Apparatus for Determining the Fatty Material in Rennet Casein. MARC FOUASSIER. *Le Lait* 15, p. 386, 1935.

Fouassier comments on the above method and refers to work of his own on a similar method. It is suggested that separation of ether and aqueous layers be expedited by concentration. A.H.J.

The Corrosion Metals in the Course of the Manufacture of Condensed Milk. G. GENIN. *Le Lait* 15, p. 159, 1935.

A review of recent work is given. It is concluded that on the basis of corrosion practically all metals constitute a better material for the construction of evaporators for milk products than does copper. A phenomenon which automatically operates to check the corrosion of metals in contact with the milk products being processed is the formation of a protective milk film. This protective film is less effective in the case of copper. A.H.J.

Improvements in the Manufacturing Process of Casein. G. GENIN. *Le Lait* 15, p. 251, 1935.

Casein manufactured by former processes was of irregular quality due to difficulties in (1) precipitating at the right hydrogen ion concentration, (2) in removing milk salts and lactose and (3) in removing the acid used for precipitating the casein. The present method yields an improved product by solving these difficulties. Hydrochloric acid of specific gravity 1.2 which has been diluted to 1 to 4 with water is used as the precipitating agent. The milk is heated to 44° C. before addition of the acid. Immediate mixture of the milk and acid in a uniform manner allows rapid separation of the curd from the serum. The use of hydrochloric acid yields soluble salts with the inorganic constituents of casein. Effective washing allows the ready removal of these salts and other soluble milk constituents. Pressing the curd between special rollers prevents the formation of large aggregates of casein. Rapid drying of the small casein particles prevents the formation of protective skins under which hydrolysis may proceed. A.H.J.

The Manufacture of Milk Sugar. G. GENIN. *Le Lait* 15, p. 627, 1935.

After removing the casein from skimmilk, the serum is neutralized with calcium or barium carbonate and then heated in a special autoclave to cause coagulation of the albumin. The coagulated protein is removed by filtration, siphoning, or decantation and the filtrate concentrated under vacuo to a 60 per cent solids content. The concentrated filtrate then goes to the crystallizers where a crude lactose containing 10 to 15 per cent of impurities (salts and albumin) is obtained. The crude lactose is dissolved and decolorizing carbon added. Acetic acid to precipitate the protein and magnesium sulphate to remove the phosphoric acid are then added and the solution heated to 90° C. after which the solution is filtered through a filter press and again concentrated under vacuo to a solids content of 60 per cent. After allowing the

concentrated solution to stand for several days, the lactose crystallizes and is removed by centrifugation. In order to obtain a white powdered lactose a further refining is necessary. The partially refined lactose is dissolved to give a solution of 15° Baumé and a small amount of aluminum sulfate or calcium chloride is added. The solution is then passed through the filter press and concentrated to a Baumé of 22°. The refined lactose crystallizes from this solution and is separated by centrifugation. Uses of lactose are also discussed. A.H.J.

The Production of Artificial Wool in Italy and Its Repercussions on the Dairy Industry. GEORGE RAY, Chief of the Intern. Institute of Agr. of Rome. *Le Lait* 16, p. 148, 1936.

In the making of artificial wool either dry casein or washed casein curd may be used. The casein is first dissolved in an alkali or alkaline salt solution and the solution then matured and passed through a draw plate in order to obtain the filaments. The filaments pass into an appropriate bath where they are rendered solid. After removal from the bath the threads are dried. The threads thus obtained closely resemble woolen strands in tenacity, insulating value, hygroscopicity and drying properties. A given weight of casein yields about the same weight of the artificial wool. In order to yield sufficient casein to replace wool, a considerable increase in cow population would be necessary with consequent increase in the supply of butter. It is suggested that the whey remaining after the casein has been precipitated from the skim milk be worked up as feed for swine. A.H.J.

ICE CREAM

Trucking Problems and Costs. A Preliminary Report on the Trucking Survey. O'NEAL M. JOHNSON, Intern. Assoc. of Ice Cream Mfgs., Washington, D. C. *Proc. 35th Ann. Conv. Intern. Assoc. of Ice Cream Mfgs.* 3, p. 39, Oct., 1935.

The survey included the following types of trucks which were reported. The percentage of the total represented by each type is given.

Trucks by Type Refrigeration

Solid carbon dioxide	24.15 per cent
Mechanical or electrical unit	11.39 per cent
Cartridge	36.73 per cent
Open body, no refrigeration	3.41 per cent
Ice and salt	23.98 per cent
Miscellaneous	.34 per cent

The useful life of trucks, total mileage, and total operating cost per mile were found in this survey to be as follows:

<i>Type of Truck</i>	<i>Useful Life in Years</i>	<i>Miles</i>	<i>Total Cost Per Mile</i>
Ice and salt, less than 2.5 tons	4	84,000	\$.1685
Ice and salt, 2.5 tons or more	5	91,000	.2830
Other than ice and salt, less than 2.5 tons	5	95,600	.1370
Other than ice and salt, 2.5 tons or more	6	120,000	.1990

Ninety-five per cent of those answering considered it cheaper to own and operate trucks for routes in excess of 75 miles rather than to hire trucks. Seven per cent of those answering use electric trucks and only 2 per cent use horses and wagons.

M.J.M.

The Cost of Manufacture and Distribution of Different Products. L. C. ANDERSON, General Ice Cream Corp., Schenectady, N. Y. Proc. 35th Ann. Conv. Intern. Assoc. of Ice Cream Mfgs. 3, p. 29, Oct., 1935.

In the past costs were determined on the basis of gallonage. This practice was satisfactory because only one test of ice cream was made and novelties amounted to very little. The ice cream business today is vastly different; bulk ice creams of different compositions are sold and novelties frequently represent as much as 25 per cent of the sales. A good cost system must follow through the manufacturing process for each individual product.

Material costs can be computed easily for each product. Mix making costs differ because some products are made without homogenization while others are heated and homogenized. Freezing costs vary because ice cream is frozen in the ice cream freezers while some products are frozen without agitation. The cost of different packages of ice cream differ in the way they are handled from the freezer to the hardening room. Other costs which must be distributed to the different products are power, light, heat, refrigeration, depreciation and repairs, delivery, selling, and general administrative expenses.

Reasonably reliable costs for each individual product handled are necessary in order to determine sales prices and policies with respect to handling the various items sold.

M.J.M.

The Cost of Serving Small Dealers. E. W. CREDICOTT, Freeport Dairy and Produce Co., Freeport, Ill. Proc. 35th Ann. Conv. Intern. Assoc. of Ice Cream Mfgs. 3, p. 22, Oct., 1935.

In studying the problem of the small account it was found that the cost varies considerably. Two accounts of the same volume may have different costs. When two things are being sold—ice cream and service (distribu-

tion); the cost of the service is the variable. Under service costs four divisions should be studied; cabinet depreciation, cabinet maintenance, selling cost and delivery and trucking cost.

Cabinet depreciation was charged to each account only for the months during which the cabinet was used. Cabinet maintenance was charged on a "per machine" basis. For the first seven months of 1935 the cost per machine varied from \$1.91 to \$2.91 a month. The selling and advertising cost was charged on an account basis and for 1935 varied from \$3.02 to \$6.31 a month per account. Charging delivery on a gallon basis proved inaccurate as did charging on an account basis. The per gallon weighted average for a 300-gallon account for the year was \$53.09 while the average per account was \$73.19. Delivery costs vary widely for an account located on an existing skeleton route as compared with another off the regular route.

No fixed rules for determining costs can be given. The above general divisions of costs should be made and intelligently applied to each account. Such factors must be taken into consideration for each account as (1) gallonage, (2) whether or not the distributor owns the cabinet and other equipment, and (3) whether or not the account is on a trucking route. M J.M.

The Solubility-freezing Point Relationships of Water Solutions Saturated with Respect to Sucrose and Dextrose in Relation to the Storage of Sherbet and Water Ice. ALAN LEIGHTON AND ABRAHAM LEVITON, Bur. of Dairy Ind., U. S. Dept. of Agr., Washington, D. C. JOURNAL DAIRY SCIENCE 18, 12, p. 801, 1935.

Although it is known that crusting or surface hardening of sherbets and ices is due to sugar crystallization and that this crystallization may be postponed or prevented by use of definite proportions of dextrose, exact experimental data on solubilities and freezing points of this mixture are not available.

It was found in this study that the eutectic point, the lowest temperature attainable without supersaturation with the sugars, -17.9°C . (0°F .). At this temperature the mixture consisted of 52.2 per cent sucrose, 12.7 per cent dextrose, and 35.1 per cent water. The ratio of sucrose to dextrose was 4.11 to 1.0 as compared with 25 parts sucrose and 7 parts dextrose or 3.57 to 1.0 as found by Dahlberg (N. Y. Agr. Exp. Sta. Bul. 536) to be most effective in preventing sugar crystallization in ices and sherbets. A.C.D.

The Limitations of Significance of Some of the Methods of Analyzing Ice Cream. A. C. FAY, Kansas State College, Manhattan, Kansas. Proc. 35th Ann. Conv. Intern. Assoc. Ice Cream Mfgs. 2, p. 49, Oct., 1935.

The standard plate count reveals the number of organisms in ice cream which will grow under the prescribed conditions of the test. Ice cream

frequently contains saccharophilic, heat resistant organisms which will not grow in plain agar. The small amount of sugar carried into the low-dilution plates frequently supports growth of these organisms although they will not grow in higher dilution plates. These saccharophilic organisms may also manifest a different property; some agar plates may appear nearly sterile unless examined under a strong lens. The colonies are present in the expected numbers in all dilutions but special lens equipment is necessary for counting the colonies. Parallel bacterial counts on 271 samples of Kansas ice cream, using standard agar and one per cent dextrose agar, indicate that the dextrose agar is more satisfactory with 56 per cent of the samples and of no value with the balance.

The direct microscopic count has the limitation that organisms killed by pasteurization are counted along with the survivors. Another limitation is the small sample of about 0.0001 cc. of mix which is actually observed.

The colon test is of value for the analysis of perfectly fresh milk or milk which has been kept very cold. Some colon types survive pasteurization and all types will grow in milk, hence the count of colon types is of significance when growth of the organisms in the dairy product has been prevented.

The accuracy of the methylene blue test for quality in milk varies because (1) the reducing intensity varies with different types of organisms and (2) it may be induced independently of bacteria by the organic constituents of milk or (3) by leucocytes in fresh milk. It is assumed that as bacteria increase in numbers, the flora of different milks becomes practically uniform in average reducing power. An arbitrary minimum for this uniformity is about 500,000 bacteria or a reduction time of 5.5 hours. The quality of most milk is considerably above this.

M J M.

Improving Ice Cream Quality by the Proper Selection of Flavors. W. C. COLE, Univ. of Calif., Davis, Calif. *Pacific Dairy Rev.* 39, 4, p. 10, April, 1935.

The importance of choosing vanilla, chocolate, fruit and miscellaneous flavors correctly for ice cream is discussed. Such added flavors determine the quality of the finished ice cream to a large extent. Uniform high quality should be the aim.

Of the factors considered in choosing flavors for ice cream the following seem to be the most important: (1) Consumer preference as to kind and grade of flavors. (2) Flavor quality as affecting the quality of the finished product. (3) Characteristic flavor remaining throughout the storage period. (4) Costs.

W.C.C.

Federal and State Social Security Legislation. TIMOTHY J. MAHONEY, The Borden Co., New York, N. Y. *Proc. 35th Ann. Conv. Intern. Assoc. of Ice Cream Mfgs.* 1, p. 41, Oct., 1935.

The Social Security Act, which became a law on August 14, 1935, has as its principal objectives unemployment compensation, old age assistance and benefits, retirement pensions, aid to dependent children, and public health work. The bill provides for state participation. Several states have enacted the necessary legislation and others have such bills under consideration. Every individual and every employer covered by the act are taxed at the same rate. For 1937, 1938, and 1939 the employees and employer both pay a tax equal to 1 per cent of the total salary of the worker. The tax rate is increased one-half per cent every three years until a maximum of 3 per cent is reached. Payments under the act vary under the different state laws but are proportional to the amount of money paid in by each worker.

M.J.M.

Ice Cream's Interest in Milk Control Programs. W. A. WENTWORTH, Secretary, Dairy Industry Committee, Washington, D. C. Proc. 35th Ann. Conv. Intern. Assoc. of Ice Cream Mfgs. 1, p. 26, Oct., 1935.

The various state and Federal Milk Control programs, how they operate, and how they may affect the dairy industry is the subject of this discussion. The six branches of the dairy industry are urged to coordinate their relations in a consideration of legislation affecting the industry.

M.J.M.

Suggestions for the Manufacture of Chocolate Ice Cream. A. D. BURKE, Auburn, Alabama. Ala. Polytech. Mimeograph Leaflet, 1931.

Thirty-two different samples of cocoa and chocolate were studied in the preparation of chocolate ice cream. The ice cream mix used in the various tests was standardized to contain 13 per cent fat, 10.5 per cent serum solids, 15 per cent sugar, and 0.35 per cent gelatin. It was found possible to improve the flavor, body and texture, and melting resistance of chocolate ice cream by reducing the quantity of cocoa to 2.25 or 2.50 per cent as against 3.0 per cent most commonly used. Chocolate syrup to be added at the freezer was prepared by mixing together and processing in the usual way 1.00 pound cocoa, 0.75 pound sugar and 3.25 pound milk. This quantity was added to 40 pounds of partly frozen mix in the freezer.

When chocolate was used in place of cocoa it was necessary to make allowance for the additional fat content, using somewhat more in order to obtain the same intensity of flavor.

A.D.B.

The Industry—Its Welfare and Future. ROBERT C. HIBBEN, Intern. Assoc. of Ice Cream Mfgs., Washington, D. C. Proc. 35th Ann. Conv. Intern. Assoc. of Ice Cream Mfgs. 1, p. 20, Oct., 1935.

The author discusses the Federal laws recently passed and legislation under consideration which will have a direct effect on the ice cream industry. He also considers merchandising problems now before the industry.

M.J.M.

What Should I Know Before Buying an Ice Cream Freezer for Retail Manufacture? (No author given.) Intern. Assoc. of Ice Cream Mfgs., 1105 Barr Bldg., Washington, D. C.

This bulletin is intended as a guide for retailers of ice cream who contemplate the purchase of freezing equipment. The bulletin should be helpful in determining probable operating and overhead costs. M.J.M.

The Association Simplified System. O'NEAL M. JOHNSON, Intern. Assoc. Ice Cream Mfgs., Washington, D. C. Proc. 35th Ann. Conv. Intern. Assoc. of Ice Cream Mfgs. 3, p. 8, Oct., 1935.

The simplified system for accounting which has been developed for use in the ice cream business by International Association of Ice Cream Manufacturers, is outlined and discussed. M.J.M.

First Stockholm Plants Open. M. J. MACK, Mass. State College, Amherst, Mass. Ice Cream Field 27, 4, p. 24, Aug., 1935.

It is stated that all ice cream manufactured in Stockholm, Sweden, is packaged in the factory and that most of the ice cream sold would be classified as novelties. Ice cream is considered a warm-weather confection in Sweden and is usually sold out of doors. W.C.C.

The Manufacture of Palatable and Uniform Ices and Sherberts. C. D. DAHLE, Penn. State College, State College, Pa. Ice Cream Field 28, 4, p. 12, Feb., 1936.

The author gives the definitions adopted by Pennsylvania in 1934 for ices and sherbets. These standards include specifications for the amounts of organic acids and milk products that are permitted or required.

The recommendations of several workers in the field regarding the use of sugar and various stabilizers and are listed, but the author maintains he has not found it necessary to use corn sugar or stabilizers other than gelatin in making palatable and satisfactory ices and sherbets. W.C.C.

Where Accidents Are Most Likely to Occur. C. C. CLEMENT, National Dairy Products Corp., New York, N. Y. Ice Cream Field 27, 4, p. 16, Aug., 1935.

The author gives a rather complete list of unsafe practices and conditions which are constantly producing accidents in the ice cream industry. W.C.C.

Fruit-Flavored Mixes that Are Appetizing and Popular. C. D. DAHLE, Penn. State College, State College, Pa. Ice Cream Field 27, 4, Aug., 1935.

Recipes which the author claims have proven popular are given for somewhat over a dozen different flavored ice creams. W.C.C.

The Newer Phase of Manufacturing Water Ices. B. I. MASUROVSKY. Ice Cream Field 27, 5, p. 28, Sept., 1935.

It is reported that as a result of 176 tests sodium alginate was found satisfactory as a stabilizer for ice when used to the extent of 0.3 per cent, and mixed with the other ingredients at a temperature of 165° F. The overrun in the ices was found to vary from 10 per cent to 35 per cent during these tests which the author claimed was satisfactory. W.C.C.

How to Induce Buyers to Discriminate. F. L. KERNAN. Ice Cream Field 27, 5, p. 10, Sept., 1935.

Educating people to discriminate in favor of high quality ice cream, and further to prefer ice cream in general to competitive products, are pointed out as being essential selling problems. People will usually accept most any grade of ice cream, it is stated, but if they are given an opportunity to choose between products of different quality the majority select those which are superior. Often, however, their reasons for making a particular choice are not convincing.

The author points out eleven common defects which may occur in ice cream and describes a simple way in which the layman can detect each.

W.C.C.

How to Get the Desired Overrun in Freezer and Plant. C. D. DAHLE, Penn. State College, State College, Pa. Ice Cream Field 28, 1, p. 16, Nov., 1935.

Several methods of calculating the overrun for ice cream are discussed and examples given to illustrate the variations in overrun of a given sample depending upon the basis of calculation. It is pointed out that theoretically the overrun should be figured on the basis of the material going into the mix and that recovered as ice cream. This obviously should include such factors as accuracy of weights, spillage and losses in the freezer.

The more commonly accepted recommendations are given for obtaining the desired overrun in the freezer. W.C.C.

Elements that Influence the Texture of Ice Cream. C. D. DAHLE, Penn. State College, State College, Pa. Ice Cream Field 28, 3, p. 6, Jan., 1936.

The author discusses the texture of ice cream primarily from the point of view of the size of ice crystals. Many commonly accepted beliefs are presented. It is claimed that butterfat is more effective than are serum

solids in improving the texture of ice cream since the mechanical obstruction to the growth of ice crystals is greater in the former than in the latter case.

The effect of homogenization is claimed to be due primarily to the break up of the fat globules and the resulting increased mechanical obstruction to the growth of ice crystals. The advantages of rapid freezing are briefly presented from the standpoint of freezer design, temperature of freezing medium, forced ventilation in the hardening room, and proper manipulation of available equipment.

W.C.C.

Processing the Ice Cream Mix for the Freezer. C. D. DAHLE, Penn. State College, State College, Pa. *Ice Cream Field* 27, 5, p. 12, Sept., 1935.

The homogenization process is considered to perform the following functions: (1) prevents churning of fat during freezing; (2) improves texture of ice cream; (3) reduces aging time; (4) aids in obtaining overrun; (5) makes possible the use of butter, frozen cream, etc., in the mix and (6) produces more uniformity in mixes than could be had otherwise.

The two stage homogenizer is recommended for high fat mixes and those having high acidities. Directions are given for standardizing the acidity in mixes when they are above the adopted standard, and a warning is given against reducing the acidity below that expected if the mix were made from the best dairy products.

W.C.C.

The Correct Method of Freezing the Mix. C. D. DAHLE, Penn. State College, State College, Pa. *Ice Cream Field* 27, 6, p. 28, Oct., 1935.

It is pointed out that the horizontal type freezer has been found to be the most satisfactory for commercial operation. In the case of brine freezers efficient operation requires that the strength of brine be carefully controlled to the desired concentration; further that the optimum temperature of the refrigerant will be influenced by the (a) efficiency of freezers, (b) freezing point of the mix, (c) condition of the blades and (d) volume of brine circulated.

Certain advantages claimed for the direct expansion and continuous freezer as compared with the brine freezer are indicated.

It is finally concluded, "To obtain the best texture, the ice cream mix should be frozen as quickly as possible and withdrawn at a temperature as low as possible without sacrificing overrun and then hardened as quickly as possible, consistent with economic practices."

W.C.C.

Improved Babcock Method for Determination of Fat in Ice Cream. V. KNIASEFF. *Ice Cream Rev.* 18, 6, p. 30, Jan., 1935.

A modified Babcock method for the determination of fat in ice cream is described, which has been devised and used in the laboratory of the

Bureau of Dairy Control of the California State Department of Agriculture. The method requires two reagents. Reagent No. 1 contains water, sodium hydroxide, sodium tartrate and ammonium sulfate. Reagent No. 2 contains ethyl alcohol, normal butyl alcohol, ammonium hydroxide, ethyl ether and petroleum ether.

The average results of a number of ice cream samples tested by the method described checked within 0.2 per cent of the Mojonnier method. Individual sample variations, when compared with the Mojonnier, ranged from - .28 per cent to + .37 per cent. J.H.E.

What a Doctor Thinks About Ice Cream. M. J. BREUER, Lincoln, Nebraska. Ice Cream Field 26, 6, p. 18, April, 1935.

This physician highly recommends the use of ice cream. He states that from the point of view of tissue building and energy generated ice cream ranks far above many articles that are conveniently accepted by the public as "food."

The keynote of the value of ice cream in the dietary of the sick and undernourished is the fact that people like it, he claims. Because ice cream is cold and sweet it is often made the vehicle to carry to the patient many things he would dislike or refuse. W.C.C.

Ingredients Used in the Ice Cream Mix. C. D. DAHLE, Penn. State College, State College, Pa. Ice Cream Field 27, 2, p. 8, June, 1935.

The products most commonly used in making ice cream mixes and the conditions under which their use is recommended are clearly presented. W.C.C.

How the Dealer Can Increase His Profits. E. G. STANTON, Chicago, Illinois. Ice Cream Field 27, 2, p. 16, June, 1935.

It is pointed out that ice cream manufacturers should acquaint themselves with the fundamentals of soda fountain merchandizing and should in turn educate their dealers in these essentials. W.C.C.

Ice Cream in Reducing Diets Should be Promoted. (No author given.) Ice Cream Field 26, 6, p. 16, April, 1935.

It is urged that if the many misconceptions on the part of those interested in reducing their weight could be corrected, much more ice cream would be sold. Some people pick out a few foods comparatively high in caloric value and shun them completely regardless of their food and health value. It is claimed that many women will refuse ice cream and eat apple pie because they have been taught that apples will aid in reducing and ice cream is so rich and fattening.

A suggestion is offered that charts of comparative calories of various servings of foods be used in a merchandizing program. Another suggestion is that the legal standard for fat in ice cream should be changed so as to eliminate the criticism that ice cream is too rich. W.C.C.

Preparing and Decorating Fancy Ice Cream. W. C. COLE, Univ. of California, Davis, California. *Ice Cream Field* 27, 2, p. 11, June, 1935.

Directions are given for preparing some of the more common "fancy ice creams." W.C.C.

Recipes for Making Peach Ice Cream. JOHN CLAITOR. *Ice Cream Field* 27, 3, p. 14, July, 1935.

The method described for using fresh peaches in frozen desserts consists essentially in removing the peels by plunging in boiling and then cold water, crushing the fruit and adding sugar at the rate of one part sugar to two parts fruit. Cool and freeze. Recipes are given for making peach ice cream, peach custard, peach pie, peach sherbet, as well as individual molds using these products. W.C.C.

Improving Flavor to Attract Repeat Trade. C. D. DAHLE, Penn. State College, State College, Pa. *Ice Cream Field* 27, 3, p. 6, July, 1935.

The importance of properly selecting the ingredients of the mix as well as the flavoring used is discussed, especially with regard to the most common flavors, viz., vanilla, chocolate and strawberry. W.C.C.

How to Use Fruit to Flavor Your Ice Cream. H. A. ACKERMAN, Hydrox Corp., Chicago, Illinois. *Ice Cream Field* 27, 1, p. 9, May, 1935.

It is claimed that canned fruits are generally inferior to fresh or cold pack fruits for use in ice cream, this being especially true in the case of strawberries and raspberries. Adding the fruit at the freezer just before drawing the ice cream is the procedure recommended for commercial practice.

According to the author raspberries retain their flavor better than do strawberries. In making peach ice cream a high fat mix and the generous use of cold pack peaches are recommended. W.C.C.

Methods of Determining Strength of Cleansing and Sterilizing Solutions in the Dairy Plant. E. F. ALMY, Dept. of Agr. Chem., Ohio State Univ., Columbus, Ohio. *Ice Cream Rev.* 19, 1, p. 49, August, 1935.

Detailed procedures are given for the standard methods of determining the strength of cleansing and sterilizing solutions. J.H.E.

The Manufacture of Ice Cream in Cuba. KATHLEEN MOLESWORTH, Assist. Trade Commissioner, U. S. Dept. of Commerce, Havana, Cuba. *Ice Cream Rev.* 18, 9, p. 64, April, 1935.

Estimates of ice cream production in Cuba place the daily average at 4,000 gallons. A brief description is given of merchandising methods and the quality of ice cream sold. J.H.E.

Freezing Cream, Ice Cream Mix for Use in Ice Cream. RALPH V. GRAYSON, Polar Products, Inc., Atlanta, Georgia. *Ice Cream Rev.* 18, 10, p. 48, May, 1935.

De-aerating and freezing of milk or cream under a high vacuum into a slush, filling it into lacquer-lined tin containers, sealing under vacuum and hardening under extremely low temperatures is described as a successful way to store high quality milk and cream for consumption as the fluid product. J.H.E.

Thermal Computations in Quick Freezing Equipment. EUGENE A. TOOPEKOFF. *Ice and Refrig.* 88, p. 125, Feb., 1935.

The advent of quick freezing has resulted in entirely new equipment and new problems. The article points out that heat leakage through insulation in a sharp freezer in percentage of total demand for refrigeration varies from 29.2 per cent where the capacity is 2,126,000 cubic feet up to 42.3 per cent where the capacity is 333,000 cubic feet. In quick freezing on the other hand these losses are less than 4 per cent. Quick freezing is generally accomplished by the use of brine in the form of a mist or liquid in direct contact with the product to be frozen. Moving belts, floating pans, spray nozzles, diving bells, freezing plates, immersion cans, etc. have been made use of in designing equipment for quick freezing. L.C.T.

Minimizing Hazards in Operation of Refrigerating Systems. L. S. MORSE, Exec. Eng., York Ice Machinery Corp. *Ice and Refrig.* 89, p. 187, Oct., 1935.

A list of refrigerant hazards together with a brief discussion of each is presented. A refrigerant confinement hazard arises when the interior pressure reaches the maximum which the confining vessel will withstand. To avoid explosions, relief valves should be used and set for about 250 pounds which is 25 pounds higher than the setting on pressure limiting devices.

Other refrigerant hazards consist of leaks, hot water backing up into condenser in small commercial plants, lack of water, high normal water temperature, condenser in direct rays of sun, overcharging system, drawing air into system, leaking or fractured joints, and overloading refrigerant drums. L.C.T.

Preserving Citrus Juice by Freezing. WM. J. FINNEGAN, Consult. Eng., Los Angeles, California. *Ice and Refrig.* 88, p. 51, Jan., 1935.

The Sunset Packing Corporation of Pasadena, California, makes use of a tubular freezer (U. S. Patent 1925033, Aug. 29, 1933) for quick freezing of citrus juice packed in vacuum sealed tin cans. The freezing tubes are 20 feet in length and of such diameter that a uniform restricted, turbulent brine flow takes place over the entire surface of the can as it passes through the tube. The time required to totally solidify round cans six inches in diameter is 46 minutes. The container in passing through the tube turns more than a complete revolution in the travel of its own length. This results in uniform heat transfer and the location of the vacuum in the center of the frozen mass. Due to the velocity of the brine over the cooling surface, the overall coefficient of heat transfer is great even though the brine is only at -28°F .

The paper ends with a brief discussion of heat transfer and thermal conductivity, and raises a number of questions which confront investigators of overall coefficients of heat transfer. Freezing data are included. L.C.T.

Notes on Cork Insulation. P. EDWIN THOMAS, Mgr. N. Y. Offices, United Cork Company. *Ice and Refrig.* 88, p. 370, June, 1935.

The author discusses the development of cork tissues, and points out how it differs from the woody part of a tree. This difference is the reason why moisture cannot migrate in cork as it might in Balsa wood. Special properties of cork are described. The air cells constitute about 54 per cent of normal cork. On analysis by treatment with nitric acid, cork shows the following solid matter:

Cellulose	0.18 parts
Resin	14.72 "
Oxalic acid	16.00 "
Suberic acid	14.40 "

When preparing cork insulation it must be properly granulated, so that pressure will not collapse the natural cells. It must be properly baked so as not to explode the air cells, but at the same time fry out the natural resin to bind the particles together in a compact permanent mass.

Reason for failures of cork insulation are discussed. Air proofing of all surfaces is advisable, since refrigeration tends to create a vacuum effect in a cold storage room. Brief instructions for proper wall construction are presented. Outside walls should be waterproofed with asphalt and the inside surface of the cork should be covered with two coats of an emulsified asphalt plastic finish.

L.C.T.

Methods of Freezing Fruits and Fruit Juices. DONALD K. TRESSLER, N. Y. Agr. Exp. Sta., Geneva, N. Y. *Ice and Refrig.* 88, p. 275, April, 1935.

The author presents a brief history of quick freezing as applied to the fruit industry. A number of the problems encountered in quick freezing of fruits are discussed. Enzymes in particular are objectionable. Their effect may be minimized by the use of a moderate amount of sugar. Sugar also prevents the loss of volatile flavors as found in strawberries and raspberries. Oxidation or blackening of cut surfaces is also prevented by keeping the fruits under a sugar syrup.

Cranberries, raspberries, blueberries, plums and youngberries are usually frozen whole, while apples, peaches and pineapples are sliced. Strawberries are packed both whole and sliced. Oranges, apples and grapes are sometimes converted into juice and frozen. Strawberries may be packed with two, three or four parts of berries to one part of sugar.

A number of methods have been developed for preventing discoloration besides the use of sugar syrup. Salt brine, pineapple juice, sulphur dioxide, or vacuum treatment for apples. Citric acid may be used with peaches. Good fruit and the right variety is necessary for quick freezing. L.C.T.

MILK

Certain Problems Related to the Marketing of Homogenized Milk (continued from January issue). P. H. TRACY, Univ. of Illinois, Urbana, Ill. *The Milk Dealer* 25, 5, p. 60, Feb., 1936.

The author draws the following conclusions from his work on homogenized milk:

1. Homogenized milk has proved popular with the University of Illinois milk customers primarily because of the richer flavor that the milk has, its homogenous nature, its convenience, and general adaptability for kitchen use.

2. The curd tension of milk can be reduced by homogenization. The temperature to which the milk is heated is also important. As the pressure of homogenization is increased the curd tension is reduced. However, little is to be gained by increasing the pressure beyond 2000 pounds. Somewhat lower curd tension will result from homogenization at temperature below 140° F. Mixed milk processed under similar conditions during the year will vary in the degree of curd hardness. In the period from September to June, the lowest readings were obtained in January and the highest in October.

3. Sediment in homogenized milk is due to the settling of body cells and possibly destabilized protein. The temperature and pressure of homogenization are not important factors. Clarification before homogenization will reduce the amount of sediment and clarification after homogenization will prevent the defect entirely.

4. Milk should be processed at temperatures not lower than 116° F. and at a pressure not lower than 2000 pounds in order to emulsify the fat completely enough to prevent creaming.

5. Homogenized milk can be satisfactorily tested by the Babcock method. It is desirable to have both acid and milk at about 70° F., to add the acid in small portions and to shake after each addition. Slightly less (1.5 cc.) acid is necessary.

6. Homogenized milk has less color than regular milk as measured by the K. and E. color analyzer.

7. There is less churning of fat in milk that has been frozen and thawed if the milk is previously homogenized. Milk homogenized at 2000-3000 pounds and then frozen will have a normal appearance when melted.

8. Homogenized milk is more sensitive to the action of sunlight than regular milk. This defect is likely an effect of the light upon the milk protein and may be more noticeable in homogenized milk because of the increased protein surface. Milk homogenized in the raw state will rapidly become rancid unless immediately heated to pasteurizing temperatures.

Milk homogenized at the pasteurizing temperature may acquire a cooked flavor due, possibly, to the temperature increase resulting from the homogenizing process and the increased protein surface.

9. The homogenizer is a source of bacterial contamination if not properly cared for. This accounts for the common complaint that homogenized milk does not keep as well as regular milk.

C.J.B.

Functions of a Milk Marketing Control Program. C. A. ABELE, Alabama State Dept. of Health. *The Milk Dealer* 24, 12, p. 60, Sept., 1935.

A discussion of the various elements of which a state milk marketing control program should consist. These various elements are listed as follows:

1. Limitation of the sale of milk, in any particular marketing area, to that from sources fully conforming to public health regulations, by means of licensure.

2. Unification and limitation of the differential between retail and store resale prices, and the limitation of the spread between wholesale prices and store resale prices.

3. Establishment of a sliding ratio which the prices paid to producers shall bear to the average wholesale-retail price of milk.

4. Bonding of distributors, to assure milk producers of payment for milk delivered.

5. Elimination of trade practices inimical to the best interests of the fluid milk industry, such as rebates, discounts, combination sales, extensive distribution of free samples, etc.

6. Advocacy of the adoption of the latest form of the State Board of Health Milk Regulations.

7. Careful study of the questions of limitation of production and price stabilization in each market area, the results of the study to determine the action taken.

8. Encouragement of (a) adjustment of financial obligations of milk producers and distributors, (b) the development of concentrated efforts by all existing state agencies toward the more economical production of milk, and (c) the use of any available direct or revolving relief funds for rehabilitation of dairy and milk-plant structures.

C.J.B.

Comparative Efficiency of Farm Milk Coolers. G. H. WILSTER, H. HOFFMAN, AND F. E. PRICE, Oregon Agr. Exp. Sta., Corvallis, Oregon. Oregon Agr. Exp. Sta. Bul. 331, June, 1934.

The study involved the cooling efficiencies of a tubular surface cooler, a sprinkler cooler, a tub cooler, and a Hydro-Vac cooler. The last-named cooler can be placed on a shipping can and attached to the water supply by means of a hose. As the water enters the cooler it goes through a water jet, creating a suction which may eliminate odors from the milk. The water is projected against a water wheel, which turns a small propeller in the can and finally flows in a continuous film down the sides of the can.

With the surface cooler, it was found that the rate of flow up to six gallons per minute, the temperature of the water, and the rate of milk flow over the cooling surface all markedly affected the rate of cooling and the final temperature attained by the milk. With the Hydro-Vac cooler the length of the cooling period and the temperature of the cooling water affected the time required to cool milk to its final temperature.

In five tests with a surface cooler using 80 pounds of milk at 90.4° F., the water flowing at the rate of four gallons per minute at 52° F., it required ten minutes to cool the milk to an average temperature of 56.7° F. Under the same conditions the Hydro-Vac cooled the milk to 59.5° F. With the cooling water at 54° F. and water flowing at the rate of four gallons per minute, it required 15 minutes with a Hydro-Vac cooler, 60 minutes with a sprinkler cooler, and 90 minutes with a tub cooler to cool 80 pounds of milk from 90° to 58° F.

The bacterial contamination in the milk cooled by a sterilized tubular surface cooler and with a sterilized Hydro-Vac cooler showed that in either case the contamination was very small. The sterilized surface cooler would add only 0.62 bacterium per cc. of milk during cooling, while as a result of the contact with the air only 0.05 bacterium per cc. milk would be added.

When milk from the same lot was cooled with a surface cooler, with a Hydro-Vac cooler, and with a tub cooler, three qualified judges were unable to find much difference in the flavor of the milk cooled with the surface

cooler, or Hydro-Vac cooler, but the milk that was cooled in a tub had a less desirable flavor.

G.H.W.

The Spread Between Farm and Retail Prices for Milk. LELAND SPENCER, Cornell Univ., Ithaca, N. Y. *The Milk Dealer* 24, 12, p. 32, Sept., 1935, and 25, 1, p. 72, Oct., 1935.

Data are presented showing the spread between farm and retail prices for milk in various United States markets and especially in New York City. Illustrations are given showing the variations in spread brought about by changes in purchasing price and in retail price. Data are also presented showing the make-up of retail prices and the cost of distribution of milk in the New York metropolitan area.

The author points out that milk dealer's spread can be determined accurately only by taking the difference between the amount received for all milk and milk products sold by the dealer, and the amount paid for all milk and milk products purchased. That the first step in analyzing the dealer's spread is to recognize that it consists of two elements; namely, the cost of doing business, and profit. The author concludes from the facts at hand that while profits vary considerably from time to time and among various dealers in the same market, it appears certain that the profit item rarely, if ever, constitutes more than one-tenth of the total spread. Ninety per cent or more of the milk dealer's spread is absorbed by the cost of the several operations and services that are performed in the process of getting the milk from the farm to the consumer.

C.J.B.

What Causes Most Common Off Flavors in Market Milk? W. H. CHILSON, Am. Dy. Sci. Assoc., Dairy and Ice Cream Machinery and Supplies Assoc. Fellow, Cornell University, Ithaca, N. Y. *Milk Plant Monthly* 24, 11 and 12, p. 24 and 30, Nov., Dec., 1935.

The author lists the factors contributing the flavor of milk and points out the prevalence of oxidized flavor particularly in milk of low bacterial count. It is suggested this flavor may be a factor interfering with increased milk consumption.

The review of literature contains detailed summaries of recent experimental work on oxidized flavor of milk. Much data incident to the present study are given.

Oxidized flavor was found to develop in milk from 25-30 per cent of the cows of the Cornell herd when that milk was held at a low temperature. Metal salts accelerated the development of the flavor. However, it was not necessary for the milk from some cows to come in contact with metals for the development of the oxidized flavor. The oxidizing enzyme seemed to be present in smaller amounts during the hot months than the cold months.

This enzyme was destroyed by heating to 170° F. for 10 minutes. Copper sulphate will cause the production of an oxidized flavor in milk heated to this exposure if added in relatively large amounts. Reconstituted 4 per cent milk made from this high heat treated milk did not develop the oxidized flavor.

Reducing agents prevented the development of the oxidized flavor. Ascorbic acid (Vitamin C) added to the rate of 50–60 milligrams per liter prevented the oxidized flavor development for seven days. All vitamin C was found to be oxidized by the time the oxidized flavor was noted. The typical oxidized flavor appears to be due to the oxidation of the lecithin while tallowy flavor was the result of oxidation of oleic acid. G.M.T.

Citrus Juice-milk Products. W. E. BAIER, Rsh. Dept., California Fruit Growers Exchange. *The Milk Dealer* 25, 5, p. 41, Feb., 1936.

The author discusses the merits of beverages composed of milk mixed with citrus fruit juices. C.J.B.

Some Thoughts on Merchandising Fluid Milk. *The Milk Dealer* 25, 1, p. 90, Oct., 1935.

Approximately 18 per cent of 3,413 selected, representative families interviewed in the Philadelphia area specifically stated that they did not know what price they paid for milk. Over 90 per cent did not know the retail price of cream.

Of 2,768 families reporting on type of container, 54 per cent preferred the glass bottle, 16 per cent the paper container, and 30 per cent did not have any preference.

Data are also given showing the number of these families buying milk from retail wagons and from stores; the length of time milk has been purchased from one dealer, reasons for changing dealers, reasons for buying from stores, and reasons for buying the different grades of milk. C.J.B.

Aluminum in the Milk Plant. *The Milk Dealer* 25, 5, p. 44, Feb., 1936.

The ideal characteristics of materials used in milk plants are listed as follows:

1. Absolute insolubility of the material in dairy products under all conditions.
2. Insolubility in cleaning solutions, sterilizers, and cooling units.
3. Non-toxic and has no effects on flavor, color, or keeping quality or dairy products.
4. Attractive appearance.
5. Sufficient strength to resist high pressure, rough usage, and considerable scrubbing.

6. Excellent workability and availability in castings, seamless tubes, sheet, and other forms used in the fabrication of milk-plant equipment. This would include perfect welding.

7. Resistance to electrolysis.

8. Low cost

A discussion is then given showing how aluminum meets the above characteristics. A list of cleaners for use with aluminum dairy equipment is also given.

C.J.B.

EDITORS' NOTE: Plant operators should not lose sight of the fact that aluminum is readily attacked by certain alkaline cleaning solutions and that it is subject to electrolysis when in electrical contact with other metals.

Alkalinity Control of Washing Solutions. H. W. LEHMKUHL, Rochester, N. Y. Proc. of the 28th Annual Convention of Intern. Assoc. Milk Dealers, Lab. Section, p. 43, 1935.

Objections to two present methods of control of concentrations of washing solutions are discussed and the author proposes the use of hard fused briquets of anhydrous trisodium phosphate and sodium carbonate which are compact and slowly soluble. With these a very simple feed device is employed which has the following features: A tank holding the briquets with a wide unconstricted line leading from the bottom of the briquet tank to the wash tank. A fresh-water feed device consisting of a cup with a regulator valve outlet and an overflow which passes some of the water to the bottom of the briquet feed tank. The briquet tank will contain 20-25 pounds of this fused material in large excess of the amount required for a day's operation. The purpose of the fresh-water bypass is to dilute the concentrated solution formed at the outlet of the briquet tank. The water drip feed is of the swivel type and may be thrown off-center at any time during operation and the alkalinity feed thus discontinued.

A study of 100 installations of the briquet feed type alkalinity control have been made.

An alkalinity of 0.05-0.10 per cent (to phenolphthalein and expressed as sodium hydroxide) and about one pound per 200 cans is an average consumption.

Further study is needed to determine what variations in procedure are needed to adapt the briquet method to bottle washing.

E.F.G.

Most Desirable Composition of Chocolate Milk. R. S. CRAIG, Director Sanitary Section, Baltimore City Health Dept. Proc. of the 28th Annual Convention of Intern. Assoc. Milk Dealers, Lab. Section, p. 38, 1935.

Trade practice and consumer preference are in harmony with the minimum fat content of 2.5 per cent required by the Baltimore Health Depart-

ment. The permissible maximum cocoa content of 5 per cent and added sugar if not more than 6 per cent preclude any criticism of the product on account of too high concentration of either of these products from health standpoint. E.F.G.

A Review of Federal and State Milk Control Experience. R. B. CORBETT, U. S. Dept. of Agr., Washington, D. C. Proc. of the 28th Ann. Convention Intern. Assoc. of Milk Dealers, General Sessions, p. 74, 1935.

Legal experience with milk control reveals a tendency to carefully preserve the fundamental relationships between the several states and the federal government as set forth by the constitution.

Economic experience with milk control shows an increased price to producers but that production has been influenced as much by drought and natural factors as by milk control. Consumption has not greatly changed and spreads for distribution have increased somewhat where resale prices have been set. The rapid growth in evaporated milk sales has not continued in 1935.

Lack of enforcement has been the most serious drawback to attainment of the objectives of milk control.

Accurate data are needed to show the true effects of milk control as an economic factor. E.F.G.

The Bottle Exchange—Its Relation to the Milk Industry. W. A. McDONALD, McDonald Dairy Co., Flint, Michigan. Proc. of the 28th Annual Convention Intern. Assoc. Milk Dealers, General Sessions, p. 62, 1935.

The organization and functioning of a bottle exchange in Flint, Michigan is described. The total operating cost is given as forty-five one-hundredths of a cent (\$0.0045) per unit.

In this expense is included the matching of all individual producers' contributions to the Flint Dairy and Food Council as well as other activities calculated to promote the general good of the industry. The author expresses the opinion that a milk bottle exchange should confine itself as closely as possible to the essential functions of an exchange. A detailed profit and loss statement of the Flint Bottle Exchange is appended.

E.F.G.

Causes and Practical Methods for Control of Sedimentation in Homogenized Milk. D. A. CHARLES AND H. H. SOMMER, Univ. of Wisconsin, Madison, Wis. Milk Plant Monthly 24, 4, p. 26, April, 1935.

The introduction of the homogenization process to the market milk industry has brought forth the problem of sediment in the bottled product.

This sediment is probably of the nature of separator slime, but is prevented from settling out of the unhomogenized product by the rising action of cream. The white portion is present in normal milk while the dark portion is picked up on the farm of production. Since the sediment is so fine it escapes detection on the sediment disc.

No relation between heat stability of the milk before or after homogenization and the amount of sediment was found. The action of large amounts of citrates and phosphates in reducing the white sediment was probably due to the tendency toward solubility of the proteins.

The sediment was not adsorbed material from fat globules nor was it due to agglutination of particles during homogenization. Clarification following homogenization while the milk was yet hot promises to be a practical method for commercial control of this defect. G.M.T.

What is Bottled Concentrated Milk? R. B. STOLTZ, Ohio State Univ., Columbus, Ohio. *Milk Plant Monthly* 24, 3, p. 52, March, 1935.

Bottled concentrated milk, known also as Fresh Concentrated, Fresh Evaporated, Double Rich, and Duo-Rich Milk is milk which has had about one-half the water removed, after which the product was bottled in glass bottles and sold fresh to the consumer. This concentrated milk could then be diluted back with tap water to the composition of normal milk or used in the concentrated state as the consumer desired.

Perry W. Meredith, Fellow, American Dairy Science Association and the Dairy and Ice Cream Machinery and Supplies Association, working on the problem of bottled concentrated milk brought to light many interesting data on the subject.

A typical group of over 100 consumers were quite willing to use the concentrated product, preferring to use the product in concentrated form on cereals and in coffee. No appreciable differences between the original milk and the diluted product were detected. The keeping qualities of the concentrated milk were slightly better than those of the original pasteurized milk. The processing of the milk in the vacuum expelled some of the feed flavors as well as some of the desirable flavors. Cream layer formation occurred after four days. Homogenization was necessary. Sediment was noticeable in the bottled product unless clarification was resorted to after homogenization. Curd tension, pH, specific gravity, fat, total solids, viscosity, and titratable acidity were only slightly altered by condensing and diluting back. The cost of condensing ranged from 0.42¢ to 2.67¢ per quart, depending on several factors. G.M.T.

The Present Status of High Temperature Short Time Pasteurization of Milk. R. E. IRWIN, Penn. Dept. of Health, Harrisburg, Pa. *Milk Plant Monthly* 24, 3, p. 24, March, 1935.

High temperature short time pasteurization is used in 76 milk plants located in 12 states. These plants are distributed chiefly in Pennsylvania and New York. The points of interest to control officials and milk distributors relative to this type of pasteurization are:

1. Less floor space. Less equipment.
2. Less time required to heat the milk and clean the equipment.
3. Sterilization with hot water of all surfaces with which the milk comes in contact immediately before the milk enters.
4. Milk to milk regeneration reduces the cost of heating and cooling.
5. Elimination of dead ends, leaking valves and foam.
6. Removes the incentive and makes it difficult to underheat or shorten the holding time.
7. Destroys the usual gas forming organisms and prevents reinoculation in the pasteurizing equipment.
8. Improves the flavor of the treated milk by making long time holding unnecessary and by preventing excessive numbers of thermophilic organisms.
9. Provides a softer curd, thus more easily digested.
10. Prevents the destruction of vitamin C through oxidation.
11. Cream separation is regulated by varying the heating and holding time and the temperature.
12. The treatment of the milk may be carried on under pressure in closed equipment.

The Electropure, Stamwik, Creamery Package Precision, Kaestner Faultless, Cherry-Burrell, Isotherm, Cherry-Burrell Plate, Dairy Supply and Equipment Plate, and York Plate types of equipment are fully described and illustrated.

G.M.T.

Properties, Virtues, and Possible Drawbacks of Homogenized Milk.

P. H. TRACY, Univ. of Illinois, Urbana, Ill. Milk Plant Monthly 24, 4, p. 28, April, 1935.

The unpopularity of homogenized milk in the past was probably due to the stress placed upon cream layer and to the unfriendly attitude of some health and regulatory officials who felt that homogenization might encourage the use of substitutes for butterfat or the use of butter and skimmilk powder in place of normal milk.

Ten per cent of the University of Illinois milk route customers changed to homogenized milk after one trial. Later another 25 per cent changed to this product. Some reasons given for their preferences were:

1. Looks and tastes richer.
2. No cream adheres to bottle cap and to top of bottle.
3. No mixing necessary.
4. Better for breakfast foods.
5. No temptation to remove the cream.

6. Easy to prepare for infant feeding.
7. No cream rises to top of glass in refrigerator.
8. Makes fine milk drinks.
9. Children like it better.
10. Baby does better on homogenized milk.
11. Does not churn out when it freezes.
12. Adults would never drink other types of milk.

Experiments show there was a tendency toward fat globule rising in low pressure homogenized milk at widely varying temperatures of processing. Flashing the raw milk to 140° F., homogenizing at 2000 pounds' pressure, clarifying, and pasteurizing is suggested to give best results. Clarification is necessary to avoid sediment. The regular Babcock test can be used in making the fat tests, but care must be exercised in regard to temperatures, amount of acid, strength of acid and agitation.

The homogenizer itself may be an important source of contamination.
G.M.T.

Standardizing Milk and Cream by Centrifugal Force. D. H. NELSON, Univ. of Calif., Davis, California. *Milk Plant Monthly* 24, 6, p. 36, June, 1935.

Calculations show that the centrifugal force used in standardizing milk does not seriously affect the solids-not-fat content of the milk. G.M.T.

The Use of Plastic Cream in Making Whipping Cream. C. D. DAHLE, R. C. WELCH, AND A. O. SHAW, Pa. Agr. Exp. Sta., State College, Pa. *Milk Plant Monthly* 24, 8, p. 27, Aug., 1935.

Experiments were conducted to determine the possibilities of making whipping cream from plastic cream, containing around 80 per cent fat. From these studies the authors conclude that:

1. Plastic cream or heavy cream containing over 59.5 per cent butterfat will show a cream plug on the surface and a tendency to oil off when standardized with skimmilk to make whipping cream unless mechanical means are taken to prevent this.

2. Viscolizing pressures of 40 pounds or more are needed to prevent oiling, 80 to 100 pounds are needed to produce a product that is not coarse in appearance, but at such pressures the whipping time is greatly increased.

3. Colloid mills proved to be efficient means of producing very satisfactory whipping cream from plastic cream and frozen cream. G.M.T.

Quality Promotes Quantity, Increasing Milk Consumption with Quality Milk. M. J. ROSENAU, Pres. Amer. Assoc. of Med. Milk Comm., Prof. Emeritus of Preventive Medicine and Hygiene, Harvard University.

Proc. of the Twenty-eighth Ann. Convention, Intern. Assoc. of Milk Dealers, p. 133, 1935.

Increase in per capita consumption of milk to a peak of 40.8 gallons per year in 1929 is attributed to a growth of public confidence in this food.

About five years ago pasteurized certified milk was placed on the Boston market and today the demand for pasteurized certified milk exceeds that for raw certified milk in this city. In June, 1935, the American Association of Medical Milk Commissions amended the official methods and standards for certified milk to permit pasteurization. Several cities in which certified milk is pasteurized are named. The pasteurized product now averages less than 100 bacteria per cubic centimeter.

Certified milk should receive favorable public response from calling the attention of the public to the high quality of certified milk through the addition of this new safeguard, pasteurization.

E.F.G.

Court Decisions on Milk. JAMES A. TOBEY, The Borden Company, New York City. Proc. 28th Annual Convention Intern. Assoc. Milk Dealers, p. 125, 1935.

Some early court decisions relative to milk are cited. The decisions of courts of final appeal must be consulted in order to determine the legal principles applicable to milk control in the U. S. There are to date more than 250 separate decisions. Eight U. S. Supreme Court decisions furnish certain legal principles which the author enumerates. The I. A. M. D. plans to publish a comprehensive pamphlet on the legal aspects of milk control.

E.F.G.

Fundamentals in Efficient and Safe Cleaning of Dairy Equipment.

F. E. A. SMITH, Dairy Tech. Service Dept., The Diversey Corporation. The Milk Dealer 24, 3, p. 34, Dec., 1935.

This paper is a discussion of the importance and means of cleaning dairy utensils.

C.J.B.

The Value of Milk Judging Contests to the Milk Dealer. W. H. E. REID, Dairy Dept., Univ. of Missouri, Columbia, Mo. The Milk Dealer 25, 5, p. 38, Feb., 1936.

A discussion of how milk judging contests train the participants therein not only to judge milk but to produce and handle milk so that it will be of high quality.

C.J.B.

The Promotion of Fluid Milk Sales in Australia. S. M. BALLANTYNE, Russell Gildberg Advertising Pty., Ltd., Melbourne, Australia. The Milk Dealer 25, 5, p. 43, Feb., 1936.

An explanation of the lack of advertising of dairy products in Australia. C.J.B.

The Expanding Horizon of the Dairy Industry. CHESTER P. HOLWAY. Nat. Butter and Cheese J. 26, 13, p. 26, July 10, 1935.

The expansion of the dairy industry into Southeastern and Northwestern states offers a new mode of life to farmers in the single crop areas and is a threat to the markets of established dairy states. A survey of opinions of state departments of agriculture in 48 states and Hawaii indicate that the desirable consumption of dairy products can be increased by organizations with definite plans to educate the people to the quality and value of dairy foods. W.V.P.

Production of High Quality Milk and Cream. C. C. PROUTY, Washington State College, Pullman, Wash. State Coll. of Wash. Agr. Exp. Sta. Bul. 192, 1934.

The author describes in a short concise manner, easily understood by the farmer, how to produce high quality milk and cream. N.S.G.

Milk Bottle Containers for the Home Help Eliminate Customer Complaints. The Milk Dealer 25, 6, p. 48, March, 1936.

Dairies reporting favor the use of bottle containers for the home, as they mean satisfied customers, less exposure of the bottles, less delivery trouble, and less bottle breakage. C.J.B.

All-Purpose Cream. J. EDWARD TUFFT. The Milk Dealer 25, 6, p. 50, March, 1936.

The author describes how Arden Farms, Inc., of Los Angeles, has successfully introduced an "all-purpose cream" with a butterfat content of 31 per cent. Sales have increased markedly, particularly in quart units. C.J.B.

Abnormal Flavors and Odors of Milk. J. PIEN AND S. HERSCHDOERFER. Le Lait 15, p. 1, p. 143, p. 257, 1935.

Causes for abnormal flavors and odors in milk are the following: (1) accidental introduction of odiferous substances into the milk or the presence of such substances in the dairy where the odors may be absorbed by the milk; (2) introduction in the ration of feeds which contribute abnormal flavors, examples of such feeds being rape, cabbage, beet leaves, and many others; (3) changes in milk flavor and odor due to bacterial action, malt flavor, caramel flavor, medicinal flavors, etc.; (4) changes in flavor due to physico-chemical phenomena such as exposure of the milk to sunlight, presence of ozone or copper salts in the milk, etc.; (5) enzymic changes due

to the action of hydrolytic or oxidative enzymes on the fat; and (6) diverse changes due to the formation of trimethylamin with consequent fishy flavor from lecithin which has undergone decomposition.

The first of these flavor defects may be eliminated by proper aeration of the dairy and by keeping all odiferous materials away from dairy products. The second may be obviated by removing from the ration those foods which are known to produce off flavors in the milk or by supplying these of food to the cows as distant from the milking time as possible in order to so reduce odiferous constituents to be respired. Off flavor due to bacterial persorption is eliminated by proper sanitary precautions around the dairy and by prompt and proper pasteurization of the milk. The deleterious effects of sunlight, copper salts and ozone on the flavor of milk may of course be prevented by removing the milk from conditions where these factors become operative. The effects of oxidizing enzymes which bring about tallowy flavors in the milk may be controlled by removing from the ration of the cow feeds high in unsaturated fats, by preventing contamination of the milk with copper salts, copper operating to catalyze the production of the tallowy flavor and by introducing into the ration feeds high in their content of antioxidants. The addition to the milk of reducing organisms is also mentioned as a means of reducing the effect of the oxidizing enzymes. The effect of hydrolysing enzymes, which operate to give the milk a rancid flavor, may be prevented by prompt pasteurization of the milk. The fishy flavor due to the decomposition of lecithin may be prevented by prompt pasteurization of the milk and proper care of the milk subsequent to pasteurization.

A.H.J.

What Happens to the Cream in Paper Milk Containers. THOMAS DUFFEE, W. S. ARNOTT, AND R. R. NELSON, Applied Res. Lab., Dayton, N. J. *The Milk Dealer* 25, p. 40, Nov., 1935.

Data are presented showing the amount of cream rising on milk in paper bottles and on milk in glass bottles.

C.J.B.

Efforts to Organize and Improve Market Milk in France. A. TAPERNOUX, Prof. of Chemistry at the Veterinary School at Lyon. *Le Lait* 15, p. 480, 1935.

Milk consumption in various parts of France and in various large cities is compared. With improvement in milk quality, there has paralleled a decrease in death rate among infants.

A.H.J.

Detergents Employed in the Dairy Industry. G. GENIN. *Le Lait* 15, p. 868, 1935.

The various alkalies employed as detergents in the dairy industry are discussed and the mechanism of their action is reviewed.

A.H.J.

The Pasteurization of Milk, Its Advantages and Disadvantages. (Low temperature pasteurization.) G. GENIN. *Le Lait* 15, p. 1101, 1935.

The advantages of pasteurization are considered to be the production of a safe milk and superior keeping quality. The disadvantages are considered to be the impossibility of producing a satisfactory milk by pasteurizing a poor milk, a reduction in the quantity of cream and the modification of the milk proteins and milk salts, with possible impairment of the nutritive properties. Vitamins A, B1, B2, D and E are stated not to be affected by pasteurization, while C is rather readily destroyed, especially at the presence of oxygen and certain metals.

Advantages
of

A Coefficient of Cleanliness for Milk. A. FOURNIER. *Le Lait* 15, p. 1, 1935.

It is proposed that coefficients of cleanliness be calculated for milk on the basis of solid contaminants (which may be filtered out and weighed) and on the basis of added water. Coefficients of alteration for milk are also proposed based on changes in composition of the milk such as changes in acidity, etc.

A.H.J.

A Microbiological Study on the Filtration of Milk. J. MASEK, Polytechnic Institute at Prague. *Le Lait* 15, p. 954, 1936.

The filtration of milk, through clean filters removed considerable numbers of bacteria as determined by making plate counts in the milk before and after filtration. Contaminated filters may, however, cause an increase in the bacterial count of the filtered milk.

A.H.J.

The Sterilization of Dairy Equipment by Dry Heat. G. GENIN. *Le Lait* 16, p. 30, 1936.

A review of the literature on this subject is presented.

A.H.J.

The Flavor Defects of Milk (Oily-Rancid, Tallowy and Bitter Flavors). JOSEF PROKS AND JAROMIR GROH. *Le Lait* 15, p. 370, 1935.

Oily-rancid, bitter, and tallowy flavors are found in the milk independent of the feed given the cows. The milk of all the cows in any herd is not defective but only the milk of some of the cows. The flavor defect is not continuous but appears and disappears in the milk from time to time. Moreover, the intensity of the off-flavor varies. The flavor defect increases not only in the winter but also in early summer. In most of the cases studied, the off-flavor was found in the milk from cows in advanced stages of lactation. The oily-rancid and sometimes the tallowy and bitter flavor defects are of such a nature that if the milk is heated before the flavor has developed, its development may be prevented. Keeping the milk at temperature

to +10° C. is favorable to development of the flavor defect. Keeping the milk at temperature of 18 to 20° C. allows less rapid development of the flavor than keeping the milk at +10° C. Contact of the milk with certain metals accelerates the development of the off-flavor but such flavors may develop in certain milk which has experienced no contact with metal. Coincident with the appearance of the flavor defect, there begins a degradation of the fat to yield flavor substances soluble in water. The lipolytic enzyme which causes the degradation of the fat is found in the skimmilk. The persinoid and ultimately the bitter and tallowy flavors were not caused, in the cases examined, by microorganisms. Lipolytic enzymes were considered responsible for the development of the off-flavors. The degree of off-flavor developed was proportional to the quantity of lipolytic enzyme present. Different quarters of the udder of the same cow produced milk of varying lipolytic activity. The fermentation of milk with lactic organisms reduces the rate of development of the flavor defect but does not prevent it.

A.H.J.

The Health Benefits of a Community Nutrition Program. OLIVE B. CORDUA, San Diego, California. *Pacific Dairy Rev.* 39, 9, p. 10, Sept., 1935.

The value of a community nutrition program is set forth. It is pointed out that in dealing with the school and pre-school child we reach 39 per cent of the population. Three pertinent questions have to be answered: *Whom* are we going to teach? *What* are we going to teach? *How* is the material to be presented. All agencies should come together in a well coordinated unit if proper progress is to be made.

P.A.D.

The Use of Dry Skimmilk in the Manufacture of Cultured Milk. E. E. ALLDREDGE AND A. D. BURKE, Russellville and Auburn, Alabama. *Ala. Polytech. Inst. Exp. Sta. Bul.* 239, 1933.

A total solids content in the reconstructed skimmilk of 10.0 ± 0.2 per cent, was found most desirable from the standpoint of producing a desirable flavor, body, and texture. The dry skimmilk should be thoroughly dissolved and the reconstructed product heated to 180° F. maintained for 30 minutes, followed by immediate cooling to 68–70° F. Five per cent of added starter was found to be satisfactory in the development of the proper acidity, flavor, body, and viscosity. An acidity of 0.95 to 1.00 per cent in the finished buttermilk was most satisfactory from the standpoint of flavor in that the relatively high acidity tends to mask the slightly heated flavor apparent in the finished product. Flavor improved after 24 hours' storage at a cold temperature. In all tests it was found desirable to cool the cultured buttermilk to 50° F. or lower prior to breaking the curd.

Vigorous agitation of the curd, particularly to the point of even slight foaminess, was responsible for major defects of cultured buttermilk, especially the defects of wheying off, flat flavor, and gassy appearance of the curd, and rapid deterioration. It was found possible to restore a vigorously agitated and wheyed sample of buttermilk to its original whey-free state by removal of air under vacuum. Viscolizing the reconstructed milk prior to cooling and culturing was of no apparent benefit. Pumping the finished buttermilk was objectionable in that air incorporation occurred regardless of the temperature of pumping, type and speed of pump, and conditions of the curd.

The use of different cultures was responsible for differences in the viscosity and acidity of the finished buttermilk; however, all cultures studied produced a satisfactory product. A.D.B.

The Bacteriological Grading of Milk. A Critical Study. G. S. WILSON, Assisted by R. S. TWIGG, R. C. WRIGHT, C. B. HENDRY, M. P. COLWELL, AND I. MAIER. Med. Res. Council Special Report Series No. 206, 393 pp., H. M. Stationery Office, London, 1935. Available in America through the British Library of Information, 270 Madison Ave., New York City, Price \$2.15.

This report of the investigations by Dr. Wilson and his associates fully justifies the interest with which it has been awaited. The work was financed for the first two years by the British Empire Marketing Board, and after the dissolution of that Board by a grant from the Ministry of Health of Great Britain. The preface states that while Dr. Wilson has had the advantage of consultation with a special committee including representatives of different Government Departments, he is however, solely responsible for the conclusions reached.

This critical study is presented in two parts. Part I covering nearly 300 pages includes a discussion of the technic of tests used in the bacteriological grading of milk under four headings. Section A.—The Plate Count; B.—The Coliform Count; C.—The Methylene Blue Reduction Test; D.—Miscellaneous tests. The latter portion includes a discussion of the sediment test, the leucocyte content, the Breed smear method, acidity and pH tests, brom-thymol-blue test, keeping quality tests, laboratory pasteurization tests, the Frost little plate method and the Burri smear culture method.

Part II is a discussion of the interpretations that should be placed on the results secured from these tests.

All workers in this field will find themselves under obligation to Dr. Wilson and his colleagues for their study of the various causes of errors in counts secured by the standard agar plate technic. They make certain practical suggestions for improving this technic. American workers will not be surprised at the conclusion that the counts obtained by the present standard

agar plate technic are in general inaccurate and unreliable, but will be surprised at the conclusion that this technic should generally be replaced in milk grading work by other tests of milk quality.

Dr. Wilson and his associates have carried out valuable studies of the mechanism of the methylene blue reduction technic and reach the very interesting conclusion that a modified form of this test "seems to fulfill most of the requirements demanded of a test for the routine grading of raw milk." "The modification consists essentially in half-hourly inversion of the tubes so as to keep the fat and microorganisms in more or less homogeneous dispersion. Its effect is to shorten the time to decolorization, and by diminishing the experimental error of the test to render it suitable for the examination of high-grade milks." The author indicates that he is less certain regarding the value of this test as applied to the grading of pasteurized milk, but he believes it to be generally useful for this purpose. Some direct comparisons are made between the accuracy and variability of results secured from the modified methylene blue technic and the agar plate count that may easily be thought to imply more than is justified by the data presented.

Dr. Wilson's conclusions regarding other laboratory procedures are also of interest. He states "With the possible exception of certified milk, there seems to be no justification for the use of either the coliform test or the *coli-aerogenes* ratio test in the grading of raw milk" but that "on the other hand, the coliform test—may serve as an index of the efficiency of pasteurization" and less satisfactorily elsewhere. "The direct microscopic count has not received the attention it deserves" and "It is in the rapid grading of milk that it finds its greatest value." His conclusions regarding other miscellaneous tests are that while they may be and frequently are useful for special purposes, they are not particularly suitable for the routine grading of milk.

This book contains a report of so much valuable research that it should take its place in routine control laboratories beside the report on Standard Methods of Milk Analysis of the American Public Health Association. The statement on p. 371, that "In the United States of America, the plate count test has many strong opponents, and the general tendency is to place less and less faith in the value of this method of grading milk supplies" shows that our English colleagues find it as difficult correctly to evaluate ideas existent on this side of the Atlantic as we do to evaluate their ideas. R.S.B.

Investigation of Resazurin as an Indicator of the Sanitary Conditions of Milk. GUY A. RAMSDALL, WM. T. JOHNSON, JR., AND F. R. EVAN, Rsh. Lab., Bureau of Dairy Industry, U. S. Dept. of Agr., Washington, D. C. JOURNAL DAIRY SCIENCE 18, 11, p. 705, Nov., 1935.

As a result of two years of study the authors believe that resazurin gives more information about the sanitary quality of milk than any other chemical

indicator. The dye is reduced and changes color in milk in a manner similar to methylene blue.

For the determination of the sanitary condition of milk the resazurin test as described in the text requires only one hour, while the methylene blue test requires over five hours. Milk can be classified into four groups as regards sanitary condition by means of the resazurin test. Milks from diseased udders and milks from physiologically abnormal cows have significant effects on the reduction of resazurin, and hence the test aids in their detection. By observing the rate of color change of resazurin-milk mixtures over a period of hours of incubation, considerable information as to the flora can be obtained.

A.C.D.

The Relation of Mastitis to Rennet Coagulability and Curd Strength of Milk. H. H. SOMMER AND HELEN MATSEN, Dept. of Dairy Industry, Univ. of Wisconsin, Madison, Wis. *JOURNAL DAIRY SCIENCE* 18, 11, p. 741, 1935.

Curd strength and rennet coagulation studies were made on the milk samples from cows of the University of Wisconsin herd as segregated into normal and mastitis groups on the basis of diagnoses made independent of this study. The curd strength was determined by a modification of the Hill test. Rennet coagulation time was determined at 30° C. with commercial rennet extract added, 1 part to 2,500 parts of milk.

The average curd strength of the milk from 31 normal cows was 48.56 grams, and 39.17 grams for 15 mastitis cows. The average rennet coagulation time was 7.56 minutes for 30 normal cows, and 10.61 minutes for 15 mastitis cows.

The milk from the infected cows was also studied by individual quarters of the udder, comparing the milk from normal quarters with infected quarters. The average curd strength of the milk from the normal quarters was 45.35 grams, while the value for the milk from infected quarters of the same cows was 23.65 grams. A similar comparison for rennet coagulation time showed 9.70 minutes for the normal and 43.79 minutes for the infected quarters.

H.H.S.

The Influence of Streptococci Infection of the Udder on the Flavor, Chloride Content, and Bacteriological Quality of the Milk Produced. C. S. BRYAN AND G. M. TROUT, Mich. Agr. Exp. Station, East Lansing, Michigan. *JOURNAL DAIRY SCIENCE* 18, 12, p. 777, 1935.

Much attention is being given today to the factors affecting the quality of dairy products. It is recognized that the quality of the raw or basic material plays an important rôle in the general quality of the processed product. Observations were made where milk produced under sanitary conditions and promptly cooled was not of good quality as determined by

flavor, chloride content, leucocyte content, methylene blue reduction test, and bacteria count. Since this reduction in quality could not be attributed to ordinary factors, that cause reduction in milk quality and since streptococci of mastitis were always found present in such milk, this investigation was undertaken to determine the relation of streptococcal infection of the udder to the quality of milk produced. Cow composite and individual quarter samples of milk were collected from the infected and non-infected cows in two herds; in addition similar samples were collected from a herd having no streptococcal mastitis. The samples were kept iced until examined. Standard methods were used to determine flavor, chloride and leucocyte content, methylene blue reduction time and bacteria count. In all cases the milk from the streptococcus-free cows was of highest quality, followed by the milk produced by the non-infected quarters of streptococcus infected cows. Apparently the infection in one, two, or three quarters of a cow exerts some influence on the quality of milk produced by other quarter or quarters. According to the same tests the milk from streptococcus infected quarters was of lowest quality. These facts are most important when dairymen are interested in the production of high quality milk.

C.S.B.

Comparison of Skimmed Milk Powder Media with Standard Nutrient Agar for Bacterial Counts on Milk. ROBERT W. CANTLEY, Cornell Univ., Ithaca, N. Y. The Milk Dealer 24, 12, p. 40, Sept., 1935.

Data are presented showing the bacterial counts on various types of milk as determined by plating on skimmed milk powder media and standard nutrient agar. The following conclusions are drawn:

1. The skimmed milk powder media produced higher counts than standard nutrient agar on milk of poor quality.

2. The colonies on skimmed milk powder media are much larger than those on standard nutrient agar, and hence much easier to count.

3. It is possible to differentiate types of bacteria present in a sample of milk by their growth on skimmed milk powder media, which is not possible with standard nutrient agar.

4. Preparation of skimmed milk powder media involves no additional technique.

5. Skimmed milk powder is cheaper than the ingredients used in standard nutrient agar.

C.J.B.

Weigh Can Samples for Bacterial Analysis. A. H. ROBERTSON, N. Y. State Food Lab., Albany, N. Y. Proc. of 28th Annual Convention of Intern. Assoc. Milk Dealers, Lab. Section, p. 74, 1935.

The results of a study to determine whether the single can or vat sampling method is better as a basis of payment on grade when premium classes are defined at 10,000 and 25,000 bacteria per cc. limits indicated that while

in a few instances a producer would fall into a lower premium class by the vat sampling method there are about an equal number of instances where he will fall in a higher premium class. In other words, the method employed to enumerate the bacterial content is not sufficiently delicate in which individual cases to detect positively the presence or absence of weigh vat contamination where the successive counts do not vary excessively. A count of 100,000 was regarded as excessive and less than 1 per cent exceeded this figure.

Figures are presented to show degree of variation which can be expected from various factors involved in making plate counts. The author concludes in view of the above that the more representative weigh vat sample is fairer to all concerned than the individual can sample. E.F.G.

The Use of Tests for Colon Bacteria in Determining the Efficiency of Pasteurization and for the Detection of Contamination in the Plant after Pasteurization. J. M. SHERMAN, Cornell Univ., Ithaca, N. Y. Proc. of the 28th Annual Convention of Intern. Assoc. Milk Dealers, Lab. Section, p. 51, 1935.

Attention is called to the demonstrated ability of certain strains to survive pasteurization and of the sometimes lowered heat resistance of strains grown on artificial media. The very low numbers of heat resistant types of colon organisms present in many milk supplies make their detection difficult after pasteurization.

Actual results obtained by the author under practical conditions indicate that in only 2 per cent of the cases have colon bacteria survived pasteurization in numbers equal to one per cc. of milk. The use of colon tests must be applied with due caution recognizing the limitations of the test.

One of the most valuable uses to which the colon test has been applied in the dairy industry is for the detection of milk contamination in the plant after pasteurization. Of pasteurized milks which gave negative tests for colon bacteria at the pasteurizer, 40 per cent of the samples of the first milk bottles gave positive tests and 15 per cent of the samples representing the last bottled milk were positive. Random samples of bottled milk from the same plants gave positive tests for colon organisms in 29 per cent of the cases.

The liquid media method of detection and measurement of colon bacteria in milk is recommended and the formate-ricinoleate broth of Stark and England found to be best with the brilliant green bile of Maner and Harris as modified by Dunham and Schoenlein next. Formulae for these media are given. E.F.G.

The Use of the Dipper-Strainer at the Receiving Platform. J. F. JANSEN, Sheffield Farms Co., Oneonta, N. Y. Proc. of the 28th Annual Convention of Intern. Assoc. Milk Dealers, Lab. Section, p. 20, 1935.

Experience with the strainer dipper is cited where trouble with quality has been located when certain other methods had failed. A special type of strainer dipper to be used in individual shipper cans is described.

Samples are taken weekly or monthly by inspectors. The method of using the dipper is described and a system and forms for reporting the results promptly to the farmer are outlined. Six photographic illustrations of the appearance of the strainer dipper after a test show the various sorts of foreign material which may be present.

These are interpreted in terms of farm conditions. The author states that "strainer positive milk denotes one or more of the following conditions; mastitis, milk from stripper or fresh cows, dirty cows and poor straining, mixing of night's and morning's milk, slow cooling, poor cooling, frozen milk, dirty utensils and equipment, old milk mixed in, newly soldered cans that have been used without thoroughly removing all traces of soldering acid."

The author predicts a widespread use of this utensil as knowledge of its efficiency increases. E.F.G.

Errors in Bacterial Sampling of Milk on the Receiving Platform. ANNA KENNEDY EASTON, Abbott's Dairies, Inc., Philadelphia, Pa. Proc. of the 28th Annual Convention of Intern. Assoc. Milk Dealers, Lab. Section, p. 60, 1935.

Techniques for bacterial sampling of milk in cans, weigh pans, and at the outlet valve are described. The average of 50 separate deliveries of milk gave the following figures:

Can composite count	9,239 colonies per ml.
Weigh pan count	10,765 " " "
Outlet count	9,223 " " "

The author concludes that the weigh pan or outlet method of sampling will give reliable results, is quicker, and there is less chance of contamination by either operator or physical conditions. E.F.G.

The Commercial Manufacture of Yoghourt Milk. E. BROCHU, College of Oka, Quebec, Canada. Milk Plant Monthly 24, 5, p. 37, May, 1935.

Yoghourt, a coagulated, concentrated whole milk, has long been recognized in Europe for its therapeutic value, where its sales are increasing. Recently its manufacture has met with a considerable amount of success in Montreal, Quebec, and other Canadian cities.

"Yoghourt results from the combined action of three specific strains of bacteria, namely, *Streptococcus thermophilus*, *Bacterium bulgaricum* and *Plocamo-bacterium yoghourtii*, on partially evaporated whole milk. The symbiotic association of the *B. bulgaricum* and *B. yoghourtii* produces the required acidity (1.0 to 2.0 per cent) in approximately three hours. The

S. thermophilus creates the pleasant aroma and attractive flavor, and the symbiotic activity of the three brings about coagulation within three hours."

Manufacturing and operations entail:

1. "Sterilization of milk by raising temperature to boiling point.
2. Addition of skimmilk powder in the proportion of 5 per cent (i.e. $\frac{1}{4}$ lb. per gallon) to obtain a greater concentration of solids in milk or evaporation in steam kettle to $\frac{2}{3}$ of its volume.
3. Rapid cooling to 115° F.
4. Addition of starter (2 per cent) and thorough mixing.
5. Bottling and capping in $\frac{1}{2}$ pint bottles.
6. Incubation in hot water (113–118° F.) for three hours; complete coagulation occurs.

7. The Yoghourt is then placed in the refrigerator and is ready for delivery some eight hours later."

The package retails for five cents. Yoghourt is usually eaten like a custard, and may be flavored in many ways. G.M.T.

The Use of an Electric Steam Generator for the Sterilization of Dairy Utensils on the Farm. H. G. LINDQUIST, Mass. State College, Amherst, Mass. *Milk Plant Monthly* 24, 1, p. 30, Jan., 1936.

Pails, strainers, and five- and ten-gallon milk cans, previously rinsed with contaminating culture, were subject to sterilization over a small commercial electric steam generator for periods ranging from four to six minutes for the smaller utensils and from six to eight minutes for the ten-gallon cans. By this treatment utensils showing a bacteria count averaging approximately 2,000,000 per cc. of rinse were rendered practically sterile. About four minutes were required to generate steam. The amount of current required to operate the generator for an hour was 0.85 K.W.H. Exposing the utensils for 1, 2, or 3 minutes was insufficient for satisfactory sterilization. G.M.T.

Relation of Temperature and Media to Bacteria Counts. ALEC BRADFIELD, Univ. of Vermont. *The Milk Dealer* 25, 6, p. 41, March, 1936.

The use of a modified medium composed of trytone, glucose, skimmilk, and agar was compared with the standard method for obtaining the bacteria count of milk. An incubation temperature of 32° C. was compared with 37° C.

The author drew the following conclusions: The modified medium and lower incubation temperature will give consistently higher counts on raw milk than will the present standard method. The temperature of incubation has a greater effect upon this increase in count than the composition of the medium. The medium used produces colonies that stand out clearly and are easier to count than those grown on a standard media. C.J.B.

Catalase of the Lactic Acid Bacteria. DAGMARA TALCE-NIEDRA. *Le Lait* 16, p. 225, 1936.

Certain strains of the true lactic acid bacteria (of the group *Streptococcus lactis*) product catalase. If strains of facultative anaerobes are cultured the catalase activity is not high. Catalase activity cannot serve as a means of defining the quality of lactic ferments. A.H.J.

The Hygiene of the Dairy in Relation to Infant Mortality. ACHILLE HAUSER AND MARC FOUASSIER. *Le Lait* 15, p. 141, 1935.

During the period of life when the main nutrition of the infant comes from milk, infant mortality has shown a notable decrease between the year 1902 and 1932. A.H.J.

A Method for Determining Bacillus Coli in Milk, Buttermilk, and Cheese. M. LERNER. *Le Lait* 15, p. 833, 1935.

After testing various methods for determining *Bacillus coli* in milk, buttermilk, and cheese, the indol method is recommended. This method gives clear results, it is easy to carry out and enables one to judge the sanitary quality of the products tested even in those cases where acidity and reductase tests have given favorable results. A.H.J.

A Mathematical Interpretation of the Reductase Test. T. MATUSZEWSKI, J. NEYMAN, E. PIJANOWSKI, AND J. SUPINSKA. *Le Lait* 15, p. 1057, 1935.

A formula was elaborated for giving the mathematical relation between the initial number of bacterial cells and the decolorizing time for methylene blue in milk when pure cultures of *Streptococcus lactis* were used. The formula was based on the following three hypotheses, that the bacteria were in a logarithmic phase of reproduction, that each cell was capable of activating the same quantity of hydrogen in unit time, and that the methylene blue, added to the milk played the role of hydrogen acceptor. The moment of the disappearance of the color of the methylene blue indicated the exhaustion of the acceptors. Thirteen cultures of the group *Streptococcus lactis* have been subjected to the experiments in sterile skimmilk. The results of these tests confirmed in a satisfactory manner the theoretical deductions. It was thus established that the colored preparation could be employed with success in estimating the living cells of young cultures, that the particular cultures showed individual variations as regards time of reproduction (from 1 hour 14 minutes to 2 hours 46 minutes) and as regards intensity of activating (from 0.71×10^{-12} to 3.02×10^{-12} mille equivalent per hour), and that between the volume of the cells and the intensity of reproduction, a negative correlation existed, while between the intensity of the hydrogen

activated and the intensity of reproduction as well as between the hydrogen activated and the volume of the cells, the correlation was distinctly positive.
A.H.J.

Consequences of the Obligatory Pasteurization (of Milk). NORMAN C. WRIGHT. *Le Lait* 15, p. 980, 1935.

Aside from the acknowledged effects of pasteurization on the hygienic and nutritive properties of milk, a question is raised concerning the effects of pasteurization on certain economic results. It has been noted that price paid to the farmer for milk has not decreased, that small vendors of milk were unable to continue in business, and that the price of milk has been kept at a level sufficiently low that consumption has increased. A.H.J.

The Hygiene of Milk. ENRIQUE M. CLAVEAUX. *Le Lait* 15, p. 971, 1935.

A discussion is given of the hygienic conditions under which milk is produced for Montevideo. A.H.J.

Directions for Conducting the Bacteriological Control of Milk. K. J. DEMETER. *Le Lait* 16, p. 138, 1936.

Various classes of milk are discussed. The various grading factors such as odor, taste, appearance, and bacteriological results are weighted. Methods of determining reductase and catalase activity, total count, and the presence of coli are described. A.H.J.

The Ammonia Content of Cow's Milk. Its Significance in Alimentary Hygiene. Application to Sweetened Condensed Milk. M. POLO-NOVSKI. *Le Lait* 16, p. 232, 1936.

The average ammonia content of 13 cows' milk was found to be 0.79 milligram per liter. The ammonia content of the milk increased on holding it at ordinary temperature. On boiling a sample of fresh milk, the ammonia content increased from 0.6 milligram per liter to 3.5 milligrams per liter. On holding the same sample of fresh milk for 24 hours, the ammonia content increased to 1.5 milligrams per liter and on boiling the held milk the ammonia content increased further to 20 milligrams per liter. The increase in ammonia was found to arise from the casein in the milk and not from the proteins in the whey. It is suggested that the increase in ammonia in held milk is due to microbial degradation of the protein. Sweetened condensed milk after storage in the cold or after exposure to 20° C. for 4 days after removal from the cold temperatures showed no higher ammonia content than did fresh boiled milk of the same milk solids content. It is therefore concluded that sweetened condensed milk may be considered a perfectly preserved product. A.H.J.

A Study of the Lecithin Content of Milk and its Products. B. E. HORRALL, Dairy Dept., Purdue Agr. Exp. Sta., Lafayette, Ind. Agr. Exp. Sta. Bul. 401, March, 1935.

The Mojonnier modification of the Roesse-Gottlieb method was used to extract the organic phosphorus along with the fat from dairy products. The colorimetric method of Deniges modified by Truog and Meyer was found to be an accurate method for the determination of organic phosphorus in dairy products. The lecithin content was calculated from the phosphorus content by multiplying it by 25.94 which is the factor for the oleyl-stearyl type of lecithin.

The lecithin content of the milk from three dairy cows shows that the fat contains a fairly constant percentage of lecithin after the fourth day of the lactation period. The colostrum milk fat contained a higher percentage of lecithin than did the fat of the milk later.

Factory milk contained a higher percentage of lecithin in the fat than did that of the fat from milk coming from normal individual cows. The average increase was 0.24 per cent.

Udder infections (mastitis) caused an increase in the percentage of lecithin in the fat of the milk when compared to that coming from normal quarters of the cow. A theory is given to explain this increase.

The lecithin content of skimmilk was on the average 13.91 per cent of the fat. Raw sweet cream contained on the average 0.428 per cent lecithin in the fat while that of raw sour cream contained 0.422 per cent. Pasteurized sweet cream butter contained an average of 0.232 per cent lecithin in the fat while that of pasteurized neutralized sour cream contained 0.170 per cent. Buttermilk from pasteurized sweet cream contained on the average 19.66 per cent lecithin in the fat while that of pasteurized, neutralized raw cream averaged 17.88 per cent. Lecithin in the fat of separator slime averaged 12.38 per cent. The results of one trial show that the lecithin content decreased materially in butter from sour cream while that of sweet cream butter remained practically the same over a storage period of 24 days.

The determination of the lecithin content in hens' eggs shows that the fat contains on the average 26.24 per cent lecithin and is fairly constant.

A method for the determination of the amount of eggs in ice cream mix is given.

B.E.H.

Soft Curd Milk Studies. M. H. BERRY, Maryland Agr. Exp. Station, College Park, Maryland. Md. Agr. Exp. Sta. Bul. 388, Oct., 1935.

The purpose of this investigation was to obtain more information regarding certain phases of the production, handling, processing and feeding value of soft curd milk.

It was found that there was not a great variation in the curd tension of the milk between milkings of the same or consecutive days over a short

period of time. Also, that the curd tension was usually fairly uniform throughout the lactation period except for a few days immediately after freshening. Colostrum formed a very hard curd upon coagulation. The average curd tension of the milk produced in one lactation period may vary widely from that produced in another. There was no variation in the curd tension of the milk under conditions prevailing at the Maryland Station. An abortion during the lactation period did not appear to have any effect upon the curd tension of the milk.

Holding milk for several days at 40° F. did not affect the curd tension when the acidity did not increase to any appreciable extent. Freezing milk had a hardening effect upon the curd. Viscolizing pressures of 3,000 to 5,000 pounds were required to change hard curd milk to soft curd milk. The greater the original curd tension, the greater was the percentage reduction following viscolization. Ordinary pasteurization temperature had no effect on curd tension, nor did heating at 160° F. for 30 minutes change a hard curd milk to a soft curd milk. A temperature of 180° F., however, had a marked softening effect on the curd. Heating milk to the boiling point in an open container usually softened the curd to below 30 grams curd tension.

In tests with rats, natural soft curd milk did not produce greater gains nor was it consumed more readily than normal hard curd milk or such milk rendered a soft curd milk by heat or pressure. C.W.E.

Vitamin D in Milk. T. M. OLSON AND G. C. WALLIS, South Dakota Agr. Exp. Sta., Brookings, So. Dak. So. Dak. Agr. Exp. Sta. Bul. 296, Dec., 1935.

The literature on this topic is critically reviewed and original data extending our knowledge in certain phases of the problem are presented. The importance of milk in the adequate nutrition of children and adults is stressed. Milk contains generous amounts of calcium and phosphorus, the bone forming minerals, which gives added significance to its content of vitamin D, the antirachitic factor concerned with their proper utilization. The biological methods used for measuring vitamin D are described and the common units used for expressing the potency are defined.

Factors influencing the amount of vitamin D in the milk at the time of its production are discussed. At the South Dakota Station four generations of cows have been produced which have never been exposed to sunshine at any time. No measurable effect on growth were noted but the milk from animals of this group failed to protect pigs from rickets as effectively as milk from a check group of cows receiving the same ration but continuously exposed to sunshine. Butterfat from a second generation no-sunlight cow contained 64.8 Steenbock units per pound while that of another similar animal on summer pasture had 227 units. Trials were also run with rats

to demonstrate the relative vitamin D potency of typical summer and winter butterfat. The greater potency of the summer butterfat was indicated by the appreciably larger bone ash percentages at both 5 per cent and 10 per cent levels of feeding. This harmonizes with other reports which show that typical winter milk contains about five, or less, Steenbock (13.5 U.S.P.X.) units per quart as compared with approximately fifteen Steenbock (40.5 U.S.P.V.) units per quart of typical summer milk. Differences in the amount of sunshine received by the cow and in the amount of vitamin D in the ration consumed undoubtedly have a part to play in influencing the relative potencies of winter and summer milk but the exact influence of each can not be stated at the present time. Investigators have found that irradiating the cow with ultra violet light has enhanced the vitamin D content of the milk subsequently produced in some cases and in other trials it has failed to do so. However, the feeding of vitamin D concentrates to cows in sufficiently large amounts has resulted, uniformly, in increasing the content of this factor in the milk. Irradiated yeast is the most favored material for this purpose at the present time.

Although breast fed babies are less subject to rickets than bottle fed babies, investigators have been unable to demonstrate appreciable amounts of vitamin D in breast milk, it being inferior to cow's milk in this respect. The reason for its superior antirachitic properties is not known.

The continued widespread occurrence of rickets among infants indicates the necessity of a food source which will supply sufficient vitamin D along with the regular diet, and milk seems to be the logical vehicle for this purpose. Three types of milk with the vitamin D content increased above the normally occurring amount have been produced and are finding their way to our markets in increasing amounts. One type, irradiated vitamin D milk, is produced by directly irradiating the fluid milk so that it contains 50 Steenbock (135 U.S.P.X.) units per quart. Another is fortified vitamin D milk, produced by adding a cod liver oil concentrate to the milk in such amounts as to give a potency of 150 Steenbock (405 U.S.P.X.) units per quart. The third is called metabolized vitamin D milk, and is produced by feeding irradiated yeast to the cows in such amounts as to produce 160 Steenbock (432 U.S.P.X.) units of vitamin D per quart.

All three types of vitamin D milk are produced under the license of the proper authority and control measures are practiced to insure a dependable product of proper potency.

The value of all three types of vitamin D milk in preventing and curing rickets has been demonstrated. There seems to be a reasonable amount of evidence to indicate that, unit for unit, the vitamin D of irradiated milk and of metabolized milk are about equally valuable for the control of rickets in infants. Limited information about fortified vitamin D milk indicates results of a somewhat comparable nature. There are numerous instances

of the prevention and cure of rickets on milk intakes sufficient to furnish 40 to 50 Steenbock (108-135 U.S.P.X.) units per day, which may indicate the approximate lower limits of effectiveness on the average, with strong probability that somewhat larger amounts will be necessary for the complete protection of the young, more rapidly growing infant.

Fortunately, vitamin D is a relatively stable product, and there is little likelihood of appreciable destruction during the short holding period before fluid milk is consumed, or by the common methods of processing this product for consumption.

C.C.T.

Quantitative Determination of Lactic Acid in Dairy Products. H. C.

TROY AND PAUL F. SHARP, Cornell Univ., Ithaca, N. Y. Cornell Univ. Agr. Exp. Sta. Memoir 179, June, 1935.

A procedure designed especially for the quantitative determination of lactic acid in cow's milk and in cream is described. It consists in the precipitation of interfering substance in one step by copper hydroxide at 45° C., direct oxidation of the filtrate with potassium permanganate after acidifying with a sulfuric-acid manganese-sulfate mixture, distillation of the acetaldehyde with a large amount of water into sulfite solution, and titration of the bound sulfite with iodine. The method was found to be accurate to 0.002 per cent of lactic acid in the original milk.

In addition to a study, when applied to milk, of the effect of variations of procedure suggested in the literature, an extensive study of the factors influencing the blank on fresh milk was carried out, leading to a suitable correcting equation. It was found that the recovery of added lactic acid was incomplete, owing to the retention of lactic acid by the precipitate. The retention was due principally to lactose in the precipitate. The retention was found to increase with the amount of lactose (or glucose) in the precipitate, and was found to agree in behavior with the distribution of a solute between two immiscible solvents. An equation to suitably correct for the amount of lactic acid retained by the precipitate under varying conditions is given, together with the evidence justifying its use.

The method is applicable to cow's milk, cream, whey, butter, buttermilk, dried milk, and evaporated milk. It is not applicable to products containing sucrose. Its application to butter will be made the subject of a separate publication.

Results obtained on applying the method to a large number of samples are given.

E.S.G.

Combination of Catalysts to Reduce Digestion Time in the Determination of Nitrogen. II. Dairy Products. C. F. POE AND R. R. SHAFER, Chemistry Dept., Univ. of Colorado, Boulder, Colorado. JOURNAL DAIRY SCIENCE 18, 11, p. 733, 1935.

Since Kjeldahl first introduced his procedure for determining nitrogen the time for digestion has been greatly reduced. In the present study many catalysts used in cereal and other products were used in analyzing different dairy products by the Gunning modification of the Kjeldahl method. When 0.3 gram mercuric oxide, 0.1 gram selenium, and 0.5 gram copper sulphate were used in combination as catalysts the digestion time was reduced from 105 to 13 minutes as compared with the standard procedure. The addition of these catalysts did not affect the accuracy of the results. A.C.D.

The Standardization of the Borden Body Flow Meter for Determining the Apparent Viscosity of Cream. J. C. HENING, N. Y. Agr. Exp. Station, Geneva, N. Y. JOURNAL DAIRY SCIENCE 18, 11, p. 751, 1935.

Due to a demand from production men of milk plants for a simple method of estimating cream body, a simple efflux instrument called the Borden Body Flow Meter was developed by Nair and Mook. Since this instrument is coming into general use in milk plants for determining the apparent viscosity of cream it seemed desirable to compare results obtained with it with results obtained by using a standard instrument such as the MacMichael viscometer.

The results of comparative tests of the two instruments with sucrose solutions ranging from 20 to 65 per cent sucrose and cream ranging in fat content from 30 to 62.5 per cent are reported in this paper. The viscosity determinations of the sucrose solutions were made at 20° C. and those of the cream were made at 15.6° C.

The viscosities in centipoises for sucrose solutions as determined by the MacMichael viscometer when plotted against the seconds as determined by the Borden Body Flow Meter give a straight line relationship passing through zero which shows that the Borden Body Flow Meter gives correct results throughout the entire range for a true solution.

When plotting the results for cream, in a similar manner, the creams containing 30, 35 and 40 per cent fat show practically a straight line relationship but for creams of higher fat content the relationship is shown by a curved line.

For creams of higher viscosity the Borden Body Flow Meter consistently gave results which were higher than those obtained with the MacMichael viscometer. However, results on very viscous creams may be transposed to approximate centipoises by the standardization data secured on cream, thereby making it possible for those using the Flow Meter to compare their results quite accurately with data reported in centipoises. J.C.H.

A Study of Variations in the Lactose Content of Milk. W. R. BROWN, W. E. PETERSEN, AND R. A. GORTNER, College of Agr., Univ. of Minn., St. Paul, Minn. JOURNAL DAIRY SCIENCE 19, 1, p. 81, Jan., 1936.

The lactose content of milk collected hourly from the cow was subject to considerable variation yet samples collected at the morning and evening milkings were rather constant in their percentage of lactose. A.C.D.

The influence of food fat of varying degrees of unsaturation upon blood lipids and milk fat. L. A. MAYNARD, C. M. McCAY, AND L. L. MADSEN, Lab. of Animal Nutrition, Cornell Univ., Ithaca, N. Y. JOURNAL DAIRY SCIENCE 19, 1, p. 49, Jan., 1936.

This study showed a definite relationship between the character of food fat and milk fat. A.C.D.

Soft Curd Character Induced in Milk by Intense Sonic Vibration. LESLIE A. CHAMBERS, The Johnson Foundation for Med. Physics and Dept. of Pediatrics, Univ. of Pennsylvania. JOURNAL DAIRY SCIENCE 19, 1, p. 29, Jan., 1936.

When milk above the melting point of the fat was subjected to intense sonic vibration the curd was softened and the fat was partially homogenized. A.C.D.

Economic and Ingenious Methods of Equipping the Laboratory. F. E. A. SMITH, The Diversey Corp., Chicago, Illinois. Proc. of the 28th Annual Convention of Intern. Assoc. Milk Dealers, Lab. Section, p. 3, 1935.

How to equip the laboratory for certain necessary tests at the lowest possible cost through improvising laboratory equipment is discussed.

The following equipment is described and is accompanied by detailed drawings in each case.

1. Water bath incubator with thermostat for the methylene blue and fermentation tests, 300 test size.

2. Incubator for standard plate count made from old, well insulated, household mechanical refrigerator, total cost of which should not exceed \$50.00.

3. Culture control cabinet for making starter culture and for incubating samples of milk and cream to determine actual keeping quality. This is made from a well constructed 75-pound ice capacity household ice box with thermostat temperature control, provision for both heating and cooling the interior and fan air circulation. The total cost should not exceed \$25.00.

4. Colony counter for standard plate counting. This is a Wolffhuegel counting glass $6\frac{1}{2}$ inches square so mounted and lighted that no light rays are directed toward the eyes except those reflected from the colonies which are thus very clearly shown.

5. Autoclave—For small numbers of routine counts a household pressure cooker may be used. For larger numbers a single wall autoclave with a

stirring attachment to facilitate solution of agar, etc., without high temperatures.

6. A power driven test tube washer is constructed mainly from the motor and flexible shaft of a used barber's clipper. A method of using this equipment is described. E.F.G.

The Cholesterol of Milk. JAMES A. TOBEY, Director of Health Service, Borden Co., New York City. *Milk Plant Monthly* 24, 7, p. 56, July, 1936.

Cholesterol found in milk serves a beneficial function in human nutrition. During irradiation of the milk, the cholesterol can be changed to form vitamin D. The author, therefore, speaks of cholesterol as the pro-vitamin D. The general occurrence of cholesterol and its chemical constitution is also discussed. G.M.T.

The Laboratory. GEORGE M. PULKRABEK, Pure Milk Association, Chicago, Ill. *Milk Plant Monthly* 24, 10, p. 36, Oct., 1935.

The author believes the laboratory plays an important part in quality improvement programs and cites numerous tests which should form a part of the daily routine in milk quality work. The minimum items of equipment required for the laboratory are listed together with layout plans and suggestions for installing electricity, steam, and water facilities. The author lists also the names and addresses of manufacturers or dealers from whom necessary laboratory equipment may be purchased. G.M.T.

A Monohydroxypalmitic Acid in Butterfat. A. W. BOSWORTH AND G. E. HELZ, Dept. of Physical Chem., Ohio State Univ., Columbus, Ohio. *J. Biol. Chem.* 112, p. 489, Jan., 1936.

The methyl esters of the fatty acids in butterfat were fractionated and the fraction of the B. P. range 165–200° C. at 15 mm. was prepared. An optically active monohydroxypalmitic acid was separated from the saponified esters. The lead soap of this acid is soluble in ether and the barium soap is soluble in benzene. K.G.W.

The Relationship of Composition to Quality in Milk. J. C. MARQUARDT, N. Y. Agr. Exp. Station, Geneva, N. Y. *The Goat World*, 20, 11, p. 7, Nov., 1935.

This study was made on samples of goat's milk collected throughout the United States in the first National Goat's Milk Scoring Contest. It is probable that the results apply to other milk.

Within a liberal range variations in fat, total solids, acidity, and curd tension did not affect the milk flavor scores. High lactose and low salt percentages were associated with high scores for flavor of goat's milk.

J.C.M.

The Simplified Method for Preparing Lactoflavine and a Study of Its Growth Effect. STUART ITTER, ELSA R. ORENT, AND E. V. MCCOLLUM, School of Hygiene and Public Health, Johns Hopkins Univ., Baltimore, Maryland. *J. Biol. Chem.* 108, 579, 1935.

A modified method for preparation of lactoflavine using whey powder and hot ethyl alcohol is described. A yield of 20 mg. from 10 pounds of dried whey powder was obtained, which, when fed to rats in daily doses of 100 micrograms, produced an average gain in weight of eight to ten grams per week. K.G.W.

Simple and Easy Methods for the Determination of Fatty Matter in Milk. SECONDO REPETTO. *Le Lait* 15, p. 15, 1935.

Ten cc. of milk, 1 cc. of isobutyl alcohol, and 10.5 cc. of 6 per cent sodium hydroxide are placed in a Gerber butyrometer and agitated vigorously for 30 seconds. The butyrometer is then placed in a water bath at 60–62° C. for 8 minutes, after which it is removed and the contents again vigorously agitated. After the butyrometer has been placed in the water bath at 60–62° C. for another 3–5 minutes, it is removed and centrifuged for 4–5 minutes. The fat content is read after placing the butyrometer in a water bath at 60° C. The Morsin butyrometer was also used in determining the fat content of milk. One cc. of isobutyl alcohol, 5.5 cc. of 5 per cent sodium hydroxide and 9.5 cc. of milk are placed in the butyrometer and agitated vigorously for 30 seconds. The butyrometer is placed in a water bath at 60–62° C. for 7–8 minutes. The butyrometer is then removed from the water bath and shaken, after which it is returned to the water bath. After standing 10–15 minutes, the fat content is read. This method does not require the use of a centrifuge and is considered satisfactory for practical use. The results obtained do not differ substantially from those obtained with accepted procedures.

A.H.J.

The Calcium Phosphates of Milk. J. BRIGANDO, CHAMP, AND CLOSSON. *Le Lait* 15, p. 382, 1935.

The salts of calcium and in particular the phosphates of calcium are considered in relation to changes in the milk. Acid milks, soft curd milks and heated milks are characterized by modifications of the proportions of the soluble and insoluble phosphates of calcium. The changes in the milk can in a certain sense be diminished by the addition of Ca and PO₄ in the proper ratio. For acid milks the phosphate added should be rich in Ca while for soft curd or "slow" milks the added phosphate should be poor in Ca. Cheeses prepared from milk which has been treated with the proper calcium phosphate are superior to cheeses prepared from untreated milk and ripen satisfactorily without the development of bitter flavors. A.H.J.

A Simple Technique Allowing Complete Analysis of Milk with a Reduced Sample of the Liquid. R. VLADESCO, Professor of the laboratory of biological chemistry of the faculty of Veterinary Medicine of Bucharest. *Le Lait* 15, p. 363, 1935.

The density of the milk is determined in small flasks provided for the purpose. In order to determine the dry matter, 2 to 5 cc. of the milk are taken up in ash-free filter paper and dried. The increase in weight of the filter paper after drying gives the dry matter. The fatty matter in the milk is determined by extracting the dry matter on the filter paper with ethyl ether, calculating the loss in weight on extraction as fatty matter. The ether extracted dry matter is next extended with tenth normal acetic acid. Lactose and soluble salts are thus extracted and the total protein remains on the filter paper and is weighed. Portions of the acetic acid extract are used for determining the lactose by the Bertrand method, chlorides by the Charpentier-Volhard method, soluble phosphates by adding magnesium acetate, ashing, dissolving the ash in 20 per cent sulphuric acid and determining the PO_4 in this solution, and solution Ca by precipitation with ammonium oxalate and titration of the oxalate with potassium permanganate. Casein is calculated from the phosphorus content of the residue on the filter paper. Phosphorus in the dry residue was determined by ashing with magnesium acetate, dissolving the ash in 20 per cent sulphuric acid and then determining the PO_4 ether by the method of Copane or by a colorimetric method involving the use of ammonium molybdate, sodium sulphite and hydroquinone.

A.H.J.

Photometric Methods in the Examination of Milk and Dairy Products.

CARL URBACH, Assistant in the Institute of Physics at the University of Prague. *Le Lait* 15, p. 129, 1935.

The lactose content of milk is determined by the use of the Pulfrich photometer. The milk to be used for the lactose determination is treated in the following manner: To 10 cc. of milk are added 40 to 60 cc. of water, 2 cc. of a solution of potassium ferrocyanide (150 grams per liter) 2 cc. of zinc acetate solution (300 grams per liter) and a drop of phenolphthalein solution. Alkali is then added to the phenolphthalein end point, the volume made to 100 cc. and the liquid filtered. Ten cc. of the filtrate are diluted to 100 cc. and two cc. of the diluted filtrate placed in a Folin tube. The procedure of Benedict (cf. C.A. 25, 4296) as applied to the colorimetric determination of lactose is then used to develop the color which is measured by means of the Pulfrich photometer. Tables are given showing photometer readings for various concentrations of pure lactose under standard conditions of using the photometer.

A.H.J.

The Storch Reaction. ORLA-JENSEN AND M. O. WINTHER. *Le Lait* 15, p. 247, 1935.

The Storch oxidase reaction for pasteurized milk has sometimes been found to be negative for freshly pasteurized milk but positive for the same milk after holding for some time. The authors state that properly pasteurized milk should show a permanently negative oxidase reaction. The oxidase reaction of milk high in leucocytes is rendered negative with greater difficulty than that of ordinary milk. Milks to which leucocytes were added in the form of separator slime decreased in the ease with which the oxidase activity could be destroyed by heat as the quantity of added separator slime was increased. A.H.J.

Contribution to our Knowledge of the Chemical Composition of Separator Slime. JAROSLAV MASEK, Polytechnic Institute at Prague. *Le Lait* 15, p. 242, 1935.

Thirty-seven samples of separator slime were collected from various parts of Czecho-Slovakia during the several seasons of the year. These were analyzed for moisture and various nitrogenous constituents. The origin of the sample played an important part in the appearance, moisture content, and odor. The content of the nitrogenous constituents varied considerably. In addition to being influenced by physiological conditions, the composition of the nitrogenous constituents was influenced by the season of the year, by pasteurization and by the chemical composition of the milk. The composition of the separator slime from different layers on the separator bowl showed variation. The layer on the bowl surface was higher in casein than the inner layers. Separator slime from pasteurized milk was higher in casein than that from raw milk. A.H.J.

The Stabilization of Milk by Electrical Deacidification. W. WINKLER. *Le Lait* 15, p. 505, 1935.

The reduction of the acidity of milk by electrical means increased its stability to heat. The keeping quality of such milk was improved as judged by rate of development of acidity. Pasteurized electrically de-acidified milk kept for 5 days at 10° C. and for 40 hours at 19 and 27° C. Non-pasteurized de-acidified milk also showed better keeping quality than milk not subjected to the de-acidification process. This process had no unfavorable effect on the flavor or odor of the milk. A.H.J.

Volatile Acidity of the Butterfat Taken from Cows Receiving Rice Bran in their Ration. NESTORE MONTI. *Le Lait* 15, p. 609, 1935.

The index of volatile acidity of the butterfat produced by cows receiving rice bran in the ration was about 20 compared with an index of about 29 for

cows receiving the usual ration of grass, hay and wheat bran. The change in the index of volatile acidity was not due to the character of the fat in the rice bran as an index of volatile acidity of about 20 was still obtained when the fat had been removed from the rice bran by extraction. A.H.J.

Lipoid Phosphorus and Phosphatides of Cow's Milk. J. E. LOBSTEIN AND M. FLATTER. *Le Lait* 15, p. 946, 1935.

By the use of several analytical procedures, the phosphatides in cow's milk were found to be about 300 milligrams per liter. The procedures used were such as to eliminate the inclusion of protein and inorganic phosphates in the extracts, which probably accounts for the low results obtained in this work as compared with the higher results obtained by other investigators. For the purification of lipoid phosphorus, the method used was to precipitate the casein with acetic acid to remove the fat from the coagulum with ether, and to extract the phosphatides from the residual coagulum with alcohol. The alcoholic extract was then submitted to fractional precipitation with acetone and magnesium chloride. In this manner about 150 milligrams of phosphatides per liter of milk were obtained. This procedure yielded about 50 per cent of the phosphatides known to be in the milk and give a product containing about 20 per cent impurities. The phosphatides of milk form a colloidal complex with the proteins or are united with the proteins by loose chemical ties to give combinations insoluble in ether but capable of dissociation in alcohol and acetone. A.H.J.

The Influence of the Duration of the Interval Between Milking on the Secretion of Milk and Its Content of Fatty Matter. J. GROH. *Le Lait* 15, p. 854, 1935.

In experiments conducted with the "hanaque-bernoise" breed of cows it was found that when they were milked three times daily, a change in the hour of milking affected only insignificant differences in the total quantity and in the total fat content of the day's milk. However, the intensity of milk and of fat formation and even the percentage of fat in the milk were dependent not only on the duration of the interval between the last milking but also on time interval which preceded the previous milking. A.H.J.

A Certain and Rapid Method of Evaluating Milks to be Subject to Pasteurization. E. VAILLANT. *Le Lait* 15, p. 961, 1935.

Milks of acidities lower than 16° Dornic are rejected as coming from unhealthy cows, milks of acidities between 16 and 20° Dornic are considered normal as concerns acidity, and milks with acidities higher than 20 are considered as questionable, probably having undergone lactic fermentation. The susceptibility of the milks to coagulation on the addition of acid was also determined. Milk at 15° C. does not normally coagulate until the

acidity becomes 70 to 75° Dornic. Also milk at 40° C. does not coagulate until the acidity attains a value of 50° Dornic. If, on adding acid to the milk, it coagulates before these equivalences of acidity have been reached, it is of questionable quality for pasteurization. The reasons for premature coagulation may be high original acidity or the presence of coagulating enzymes elaborated by bacteria present in the milk. A.H.J.

The Exactitude of the Different Methods of Dairy Control. STEFAN TAUSSIG. *Le Lait* 15, p. 1087, 1935.

In determining the productiveness of the dairy, a study was made of frequency with which milk yield and fat content should be determined. It was concluded that weekly, biweekly, triweekly and monthly tests gave equally satisfactory results. When the tests were made it appeared that samples should be collected over a 48 hour period. A.H.J.

A Test for the Freshness and the Coagulating Intensity of Milk. E. PIJANOWSKI. *Le Lait* 16, p. 1, 1936.

The general basis of the test is that milk will form a curd due to the decomposition of the calcium-casein complex when the acidity reaches a certain point (on the average 27° Soxhlet-Henkel). If the quantity of acid required for curdling a sample of milk is less than that calculated, it may be assumed that the capacity to form this curd prematurely is due in part to coagulating enzymes that have been produced by micro-organisms in the milk, e.g., *Bacillus subtilis* and others. The higher the quantity of acid required for curdling, the higher may the degree of freshness of the milk considered to be. A formula is given for calculating the degree of freshness of the milk. Correction values are given for converting titrations obtained at several temperatures to 15° C. to which temperature the degree of freshness is calculated. Tenth normal solution of sulphuric, hydrochloric, lactic, and formic acids were used in determining the degree of freshness. The first named was considered to be the most satisfactory. In determining the degree of freshness, the acid is allowed to flow very slowly into milk at the same temperature. The flask containing 30 cc. of milk is carefully and constantly agitated until curdling occurs. A.H.J.

The Surface Tension of Cow's Milk. G. BELLE. *Le Lait* 16, p. 13, 1936.

The surface tension of 70 mixed milks of the Casablanca region varied between 55.3 and 48.8 dynes at 18° C. The average surface tension was about 50.4 dynes. The surface tension of milk was highest immediately after milking and decreased about 3 dynes after 2 to 3 hours. On further holding for 24 hours the surface tension continued to decrease slightly. At 20° C. milk had about the same surface tension as at 18° C. However on cooling the milk to 10° and to 0° C. a lowering of surface tension resulted.

A minimum surface tension was obtained at 0° C. which was about 3 dynes lower than that obtained at 18° C. A.H.J.

The Electrical Deacidification of Milk. J. PIEN AND J. BAISSE. *Le Lait* 16, p. 20, 1936.

The electrical deacidification of milk by passing it between aluminum electrodes has the disadvantage of producing much foam and a precipitate of casein on the electrodes and on the floor of the deacidifying vessel. The amount of casein precipitated depends on the deacidification accorded the milk. On reducing the acidity from 24 to 18° Dornic, 3 grams of casein per liter of milk was precipitated. Fat and solids not fat were also removed from the milk as a result of electrical deacidification but the quantities removed were not as great as the quantities of casein removed. The lactic acid which disappears as a result of electrical acidification is not destroyed but is bound in the precipitated curd and neutralized by basic salts which are formed at the electrodes. Milk which has been neutralized electrically does not show any decrease in lactose ion (as it is still present bound in the protein and as neutral lactate). Milk which has never been allowed to sour can be rendered alkaline due to the basic salts which are liberated as a result of the electrical deacidification procedure. Mild treatment by the deacidification procedure does not have any effect on the flavor or odor of the milk, except as the flavor of acidity is concerned, while strong treatment gives rise to off fishy odors which cannot be removed by aeration. The off flavors and odors are increased by subsequent pasteurization. Electrical deacidification has no effect on the bacterial content of the milk. Electrically neutralized milks were not considered suitable for sale. A.H.J.

MISCELLANEOUS

The Manufacture and Applications of Pipe. W. C. MOSER, National Tube Company, St. Louis. *Ice and Refrig.* 88, p. 137, Feb., 1935.

The author discusses the type of piping most suitable for various uses including refrigeration. For the latter he recommends seamless piping, because ammonia leaks may be extremely costly, and in some cases are difficult to detect. Seamless piping is less susceptible to corrosive conditions because it is made from open hearth or electric furnace steel. Seamless piping costs from 10 per cent to 13 per cent more than butt welded or lap-welded piping. L.C.T.

Air Conditioning. C. C. WINN, Detroit Inst. of Tech., Detroit, Michigan and W. H. E. REID, Univ. of Mo., Columbia, Mo. *Ice Cream Rev.* 18, 8, p. 39, March, 1935.

A discussion of air conditioning with special emphasis on the methods commonly used to wash and filter air. Dehumidification and humidification methods are also described. J.H.E.

The Control of Corrosion in Air Conditioning Equipment by Chemical Methods. C. M. STERNE, Chief Eng. Metropolitan Refining Co., Long Island City, N. Y. *Ice and Refrig.* 89, p. 1, July 1935.

In central air-conditioning systems, corrosion exposures are of the following types:

- (1) Spray (a) Alternate, (b) Continuous.
- (2) Humid atmosphere (a) Alternate, (b) Continuous.
- (3) Water line (a) Agitated, (b) Quiescent.
- (4) Velocity.
- (5) Impingement.
- (6) Acid (due to air contamination).
- (7) Galvanic action, (due to different metals in contact).
- (8) Electrolytic action (in rare instances, due to current leakage).

The rate of corrosion by water is affected by its softness, chloride content, carbon dioxide content, temperature, oxygen content, sulphate content and pH. Drops in the pH value from 7.0 to 3.3 have been recorded for water used in washing impure air.

The author discusses the advantages and disadvantages of various protective coatings for air conditioning equipment. Results of experimental work indicate the value of a combination of sodium dichromate and sodium hydroxide as an inhibitor of corrosion. L.C.T.

Metallizing, or the Spraying of Molten Metal. E. F. BESPALOW, Managing Engineer, Choctaw Culvert and Machinery Co., Memphis, Tenn. *Ice and Refrig.* 89, p. DB, July, VTCE.

The author presents a short history, and also discusses the wide application and possibilities of the process. The minimum thickness of coating which can be applied is .0015 inch for one coat of the harder metals, and .0025 inch for the softer metals. Various thicknesses desired can be built up by applying any number of coatings. L.C.T.

What Constitutes a Satisfactory Water Supply? CLARENCE W. KLASSEN, Div. San. Eng., Ill. Dept. Pub. Health, *Milk Plant Monthly* 24, 8, p. 32, Aug., 1935.

The physical, chemical, and sanitary qualities must be considered in judging the quality of water for dairy purposes. The physical properties include, color, odor, and taste. Dairy men are seldom concerned with coloring matter in water but frequently experience difficulty with water having objectionable odors, particularly hydrogen sulphide. Tastes in water caused by

certain minerals, algae and industrial wastes may be of concern. Minerals in water may result in (1) corrosion, (2) deposits, (3) nucleus or bond for milk stone formation, (4) reduction of washing powder effectiveness, and (5) may furnish material for certain bacterial growth, especially the iron bacterium, crenothrix. Water softening processes usually remedy these difficulties.

Proper location and construction are the important factors in developing a safe source of water. Details relative to location and construction of water sources are given. G.M.T.

A Study of the Composition of Boiler Water. J. L. BRAY, Prof. of Metallurgy, Purdue University, West Lafayette, Indiana. Ice Cream Rev. 18, 8, p. 42, March 1935.

The composition of hard water, and the chemistry of the lime-soda and zeolite methods of softening are reviewed. The cause for embrittlement of boiler plate is discussed. A tabulation of the composition of feed waters used in boilers that have failed through embrittlement is given as well as the composition of water, which seldom causes embrittlement. The author points out that a low sodium sulphate ratio to alkalinity as sodium carbonate promotes embrittlement while boiler waters having a relatively high ratio of sodium sulphate to alkalinity as sodium carbonate are not likely to cause embrittlement.

To prevent embrittlement of boiler plate it is recommended that the boiler water be analyzed at regular and frequent intervals and when the requisite ratio is exceeded, steps should be taken to adjust the ratio either by suitable additions or by blowing out the boiler and starting over.

J.H.E.

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ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

BUTTER

The Carotenoids of Butter. ALBERT E. GILLAM AND ISADOR M. HEILBRON, Chem. Dept., Manchester Univ. *Biochem. J.* 29, p. 839, 1935.

A chromatographic process (Tswett) was employed to determine the nature of the carotene in butter obtained from fat of normal and colostrum milks. The data show that butter contains both α and β carotene, and that relative amounts of the isomerides vary considerably in different samples, the ratios of α to β forms ranging from 1.22 to 9:1 in normal butter, and 1.18 to 7.1 in colostrum butter (one sample mainly β form).

In addition to α and β carotene, more highly pigmented butters were found to contain minor amounts of other petrol phasic lipid pigments, characterized as kryptoxanthin and lycopen. K.G.W.

Proper Salting—Its Importance in the Manufacture of High Quality Butter. C. D. LOOKER, Dir. of Res., Intern. Salt Co. *Nat. Butter and Cheese J.* 26, 15, p. 18, August 10, 1935.

Clear flake or cube salt, 40 to 60 mesh, when it is practically free from chemical impurities and has been held in dry cool storage, aids in the production of high quality butter. Uniform distribution of salt and thorough working of the butter are essential W.V.P.

Butter and Cheese Industry Developing in Argentina. JULE B. SMITH, Assistant Trade Commissioner, Buenos Aires. *Nat. Butter and Cheese J.* 26, 15, p. 10, August 10, 1935.

Data are given to show approximately the amounts of milk produced, methods of utilization and exports and imports of manufactured dairy products. In April, 1934, the ministry of agriculture formed "La Junta Reguladora de la Industria Lechera" to improve the economic status of the industry and the quality of the dairy products. Dairy firms are required to cooperate with the junta. About 10 per cent of the dairy equipment comes from the United States despite unfavorable exchange control and keen competition from European manufacturers. W.V.P.

Experiments Concerning Fishy Flavor in Butter (A Review of the Subject). W. RITTER. *Schweizerische Milchzeitung* No. 1, p. 101, 1934.

Lecithin splitting into trimethylamine is responsible for fishy flavor. Iron and copper are associated with the action. Oxidation without these

metals also causes this flavor. Bacteria are also frequently associated with this condition. W.R.

Fishy Flavor in Butter (The Metal Content of Butter and Cream).

W. RITTER AND M. CHRISTEN. *Schweizerische Milchzeitung* No. 5, 1935.

The authors found that increased amounts of iron and copper in butter and cream frequently favored fish flavor development. Notable exceptions indicated that other points were involved. Bacterial action appeared to be significant. W.R.

Fishy Flavor in Butter (Influence of Adding Salts of Iron and Copper to Milk and Cream). W. RITTER AND M. CHRISTEN. *Schweizerische Milchzeitung* No. 7, 1935.

Tallowiness in milk was associated with 0.01 milligram of copper per liter. This defect was increased with high temperature pasteurization and holding cold 24-48 hours. A similar effect was produced with 0.5 milligram per liter. Adding hydrogen peroxide or hydrogen ions, or N-Methyl-p-aminophenol-sulfate stopped or retarded the development of tallowiness. Ascorbic acid did the same. Malic acid had a like action. Increasing heating temperatures decreased the tendency for this flavor to develop. W.R.

Experiments Dealing With Fishy Flavor in Butter (The Role of "Reduktobacterium frigidum"). W. RITTER AND M. CHRISTEN. *Schweizerische Milchzeitung* No. 12, 1935.

The authors found that certain alkali producing bacteria retarded fishiness in butter. Active cultures were required to do this work. W.R.

MILK

Production of High Quality Whipping Cream and Coffee Cream. R. T.

KENNY, University of Illinois, Urbana, Ill. *Milk Dealer* 25, 8, p. 78, May, 1936.

The author discusses the methods of increasing the viscosity of cream, causes and prevention of cream plug, causes and prevention of milk layer in bottled cream, normal acidity, and neutralization of cream, bacterial count of cream as compared with the count of milk from which it is separated, feathering of cream, factors affecting the whipping of cream, and the method of dispensing whipped cream known as instant whip. C.J.B.

Health Education Program. GEORGE H. WATSON. *Milk Dealer* 25, 8, p. 38, May, 1936.

The author describes a Health Education Program which secured results for Foremost Dairies, Birmingham, Alabama. C.J.B.

Factors Responsible for Off Flavors in Milk. P. H. TRACY, University of Illinois, Urbana, Illinois. *Milk Dealer* 25, 8, p. 114, May, 1936.

A discussion of some of the causes and methods of preventing off flavors in milk, especially rancid, oxidized, and tallowy flavors. C.J.B.

Delivery Cost Wastes that Eat into Profits. A. E. FRIEDGEN. *Ice Cream Field* 28, 6, p. 10, April, 1936.

The author points out that many wastes in the operation of delivery trucks could be eliminated if the proper records were kept and used as a basis of economical operation. W.C.C.

Effects of Seasonal Milk Production on Marketing Costs. WAYNE CASKEY, Dept. of Agr. Econ., Univ. of Ill., Urbana, Ill. *Milk Dealer* 25, 6, p. 68, March, 1936.

A study has been made of the effects of seasonal milk production on marketing costs in the New York, Philadelphia, and St. Louis milk sheds. The following conclusions are made:

1. The use of a weighted average price for paying the producers under the classified or use plan in the New York milk shed since May, 1921, resulted in widening the seasonal production of milk in this area.

2. The use of a basic-surplus plan for paying producers in the Philadelphia milk shed from 1919 to 1926 resulted in substantially narrowing the seasonal production in this area.

3. The New York milk shed could be reduced from a radius of 580 miles to 400 miles and still supply the market demand for whole milk, cream, and condensed milk, if seasonal milk production in New York were adjusted to the Philadelphia seasonal production.

4. The annual seasonal surplus in the New York milk shed could be reduced from 26 per cent to 10 per cent if its seasonal production were adjusted to the Philadelphia seasonal production.

5. A high seasonal surplus lowers the average price to producers since the market values of the manufactured products which absorb this surplus usually are not sufficiently high to pay premiums for high quality milk.

6. A wide seasonal production of milk results in the use of more trucks hauling the product than are necessary when the same volume is produced uniformly throughout the year. In a study of trucking operations in the St. Louis country plant areas, it was found that about one out of each four trucks now in use could be eliminated if the seasonal production in those areas were reduced to that in the Philadelphia milk shed.

7. A wide seasonal production of milk results in higher unit costs of country plant operations than a narrow seasonal production, since with a given capacity, total operating costs are about the same throughout the year.

C.J.B.

Bottle Losses—How to Reduce Them. C. A. MOHR, Madison Consumers' Co-Operative, Madison, Wis. *Milk Dealer* 25, 7, p. 84, April, 1936.

The author discusses breakage due to faulty glass or to careless handling prior to delivery to the milk plant and breakage after delivery to the plant. Various tests to which bottles should be submitted before acceptance are detailed and suggestions for preventing breakage and loss at the dairy are given. C.J.B.

Eliminating Butterfat Losses and Waste in Milk Plant Operation. J. R. BUTLER, Midwest Dairies, Inc., El Paso, Tex. *Milk Dealer* 25, 7, p. 44, April, 1936.

The author describes how Midwest Dairies, by daily testing and constant vigilance, reduced butterfat losses from around 5 per cent down to 1 per cent or less. C.J.B.

Allocating Milk Plant Costs by the Factor System. JOHN R. PERRY. *Milk Dealer* 25, 7, p. 40, April, 1936.

The author describes the factor system of milk plant accounting. In this system the plant costs of the various items handled are obtained so that the cost of each item as it leaves the plant can be found by adding the plant cost to the cost of the item laid down at the plant. The advantages of the factor system are simplicity, inexpensiveness, quickness, and accuracy. C.J.B.

Mechanical Can Washing a Necessity. J. M. TRITTENBACH, Sales Manager, Lathrop Paulson Co. *Nat. Butter and Cheese J.* 26, 15, p. 22, August 10, 1935.

Efficient mechanical can washing delivers clean, odorless cans which are practically sterile at a cost of approximately 7 mills per can. W.V.P.

A Study of Milk Consumption in an Outer London Suburb. E. H. R. Southard. *Lancet*. 230, p. 235, Jan. 25, 1936.

A survey of milk consumption in Southall, an industrial district of 47,000 population on the fringe of London, showed that just under half a pint per person is used daily. By means of the phosphatase test and bacterial counts, it was determined that 86 per cent of all milk used could be classed as "safe," and that 82 per cent was efficiently pasteurized. The author advocates compulsory pasteurization of all milk which is not otherwise bacteriologically controlled. J.A.T.

Plumbing Hazard Survey of Pasteurization Plants. W. SCOTT JOHNSON, Sanitary Engineer, Division of Health, St. Louis, Mo. *Am. J. of Pub. Health* 26, 3, p. 229, March, 1936.

The author discusses the potential dangers of the contamination of milk from faulty plumbing in pasteurization plants. A survey of six plants revealed 210 plumbing defects involving 28 different kinds of milk plant equipment.

Defects are classified according to six general types and according to equipment involved. Faulty conditions are due to defective plumbing installations and fixtures, poor design of milk plant equipment, and inexperienced planning of the location and capacities of sewage systems within milk plant buildings. These hazards to health should be eliminated. The responsibility for the administration of the program for correcting existing defects and prevention of future ones should rest with the health department.

M.W.Y.

Vote Permissive Pasteurization of Certified Milk at Conference. TORREY STEARNS. *Cert. Milk* 10, 111, p. 3, July, 1935.

Permissive pasteurization was voted into the official "Methods and Standards for the Production of Certified Milk" at the joint conference of the Certified Milk Producers' Association of America and the American Association of Medical Milk Commissions held June 10 and 11 at Atlantic City, N. J. The action permits producers of certified milk throughout the United States to market pasteurized certified milk in addition to the widely-known raw certified milk, provided this meets the approval of the local Medical Milk Commission.

W.S.M.

Metal-free Dairy Products an Essential Adjunct of Metal-free Treatment.

L. E. GAUL AND A. H. STAND, New York. *Cert. Milk* 10, 107, p. 3, March, 1935.

The authors point out the possible relationship between various disease processes and the absorption of relatively minute quantities of the metallic elements present in water, beverages, dairy products and foodstuffs, including dairy products. The metallic content of dairy products was determined by a spectrographic analysis, the technique of which is outlined. Special advantages of the spectrographic method of analyzing dairy products are given.

W.S.M.

Some Physico-Chemical Properties of Lactose. H. H. SOMMER, Dairy Dept., Univ. of Wis., Madison, Wisconsin. *Ice Cream Rev.* 18, 8, p. 46, March, 1935.

Lactose exists in milk or any solution in two modifications—alpha-lactose and beta-lactose. Alpha-lactose is the least soluble of the two modifications and under ordinary conditions will be the first to crystallize. The two forms exist in solution in equilibrium at a definite ratio of one to the other. When

some of the alpha-lactose crystallizes out, this equilibrium is disturbed and some of the beta-lactose will undergo transformation into the alpha modification.

Both forms of lactose are optically active and the optical rotation can be measured in angular degrees by the polariscope. The two forms are dissimilar in their optical rotatory power. When alpha lactose is dissolved and the optical rotatory power determined the very first reading will be due to the alpha-lactose. As time passes some alpha will change to beta-lactose and there is a corresponding change in the polariscope reading. This drift or change in the reading will continue until the two modifications are in equilibrium. The phenomenon is known as mutarotation. J.H.E.

Magnesium Studies in Calves. I. Tetany Produced by a Ration of Milk or Milk with Various Supplements. C. W. DUNCAN, C. F. HUFFMAN, AND C. S. ROBINSON, Mich. Agr. Exp. Sta., East, Lansing, Michigan. *J. Biol. Chem.* 108, 35, 1935.

Previously reported experiments have shown that attempts to raise calves to maturity on a ration of whole milk alone have consistently failed, except when the whole milk ration was supplemented with alfalfa hay. On a whole milk ration, a train of symptoms of functional disturbance, such as irritability, excitability, anorexia, neuric muscular activity and tetany, followed by death, may occur. These symptoms closely parallel those following extirpation of or injury to the parathyroid glands; the frequent occurrence of hypocalcemia has often been considered an explanation for the condition. The symptoms, however, have been observed when the blood calcium was normal.

Experiments with 25 calves given a whole milk ration with or without various supplements, such as cod-liver oil, linseed oil, minerals, yeast, and parathormone were conducted. Tetany was observed to occur in twenty calves which had normal blood calcium and inorganic phosphorus; with five other calves tetany was observed when blood calcium and phosphorus were normal, and was associated with a low blood magnesium. The Ca: Mg ratio in calf blood is normally 4: 1 to 5: 1, whereas a sustained whole milk ration increases this ratio 8: 1 to 10: 1, owing solely to a decrease in blood magnesium. Normal blood magnesium values range from 2.25 to 2.75 mg. per 100 cc. of plasma, and in calves suffering from low magnesium tetany, 1.2 to 1.6 mg. Low magnesium tetany does not occur on the average calf's ration because they are able to utilize magnesium more efficiently when they have access to roughage. While calcium and phosphorus requirements are maintained by increasing the milk intake, the same is not true for magnesium.

K.G.W.

The Effect of Ingested Cod-Liver Oil, Shark Liver Oil, and Salmon Oil Upon the Composition of the Blood and Milk of Lactating Cows.

C. M. MCCOY, AND L. A. MAYNARD, Cornell Univ., Ithaca, New York.
J. Biol. Chem. 109, 29, 1936.

The feeding of cod-liver oil to a lactating cow is known to cause a significant reduction of the fat percentage in the milk. The changes that take place within the body that may lead to this repression of fat secretion have been unknown. Five cows were fed 168 cc. of cod-liver oil, shark liver oil, and salmon oil for periods of two weeks with periods without oil between. The usual fat repressant action of cod-liver oil was observed, whereas the significance of the effects of the other oils was wanting. Feeding of pasture grass did not counteract the effect of cod-liver oil. The non-saponifiable fraction of cod-liver oil had no effect upon milk fat, while the tri-glycerides seem to carry the injurious repressant fraction. The ingestion of the oils did not affect normal milk yield and in every case a rise occurred in the iodine number of the milk fat. Blood samples were taken simultaneously from the mammary and jugular veins of three of the cows at weekly intervals. The analyses indicate that the mammary gland takes true glucose from the blood rather than other reducing substances; similarly, the total plasma lipids of mammary blood was significantly less than in jugular blood. No similar reduction was observed in the amounts of blood plasma lipid phosphorus and inorganic phosphorus. The data indicate that cod-liver oil exerts its effect directly on the mammary gland, rather than by alteration of blood composition.

K.G.W.

Prophylaxis of Rickets in Premature Infants with Vitamin D Milk. L. T.

DAVIDSON, K. K. MERRITT AND S. S. CHIPMAN, Dept. of Diseases of Children, Columbia Univ., the Babies Hospital and the Sloane Hospital for Women, N. Y. *Am. J. Dis. Child.* 51, p. 1, Jan., 1936.

Eleven premature infants were given vitamin D milk, from cows fed irradiated yeast, during the first six months of life to determine how far they could be protected from rickets by this means alone. Roentgenograms of the forearms and wrists were made bimonthly from birth to four months of age and then monthly through the sixth month. Serum calcium and phosphorus were determined monthly. By roentgenogram, two of the infants remained free from rickets throughout the study; the other nine showed rickets of mild degree from the third to the fifth month, which had satisfactorily healed by the sixth month without change in the antirachitic regimen. In only one instance was the calcium-phosphorus product found to be definitely lowered.

W.H.R.

Influence of the Ration on the Vitamin C Content of Milk. W. H. RIDDELL, C. H. WHITNAH, J. S. HUGHES AND H. F. LIENHARDT, Kans. Exp. Sta., Manhattan, Kan. *J. Nutrition* 11, p. 47, Jan., 1936.

Using two cows to a lot the vitamin C content of the milk produced from the following rations was determined by both biological assay and chemical test: 1. Sorghum silage and a grain mixture with access to good brome and bluegrass pasture; 2. A winter ration of alfalfa hay, sorghum silage and a grain mixture; 3. A winter ration of alfalfa hay and grain. The results indicated that the rations studied had no significant influence on the vitamin C content of the milk.

L.A.M.

Examinations on Heat Resistant Strains of *B. coli*. W. HENNEBERG AND H. WENDT, Prussian Dairy Research Institute, Kiel, Germany. Zentr. F. Bact. 2, 93, p. 39, October, 1935.

Strains of *B. coli*, that survive 63° C. for 24 to 30 minutes are very rare in milk. The same is true with pasteurizing apparatus. It may be that they live there in coccoid forms so that they may not easily be distinguished from the almost abundantly occurring micrococci. It was not possible to distinguish the resistant and non-resistant strains by any other differential method. The ability to resist heat was found to be very variable with the same strain, an experience which had been also made independently at the research institute in Weißenstephan (By Demeter). It is furthermore demonstrated that a persistent good nutrition (extract of bruised rye) may transform non-resistant strains into resistant ones. A special "physiological condition" may play an important part. In a few cases the heating of the bacteria was followed by certain physiological and morphological changes, namely, the colonies lost the red color on Endo-fuchsin-agar, the cells became round, and the ability of acid production vanished. Those coccoid forms are to be considered as degeneration forms.

K.J.D.

On the Symbiotic Functions of *Oidium Lactis*. J. B. LINNEBOE AND E. G. HASTINGS, Univ. of Wis., Madison, Wis. Zentr. f. Bact. 2, 93, p. 278, Jan., 1936.

The bacteria, whose symbiosis with *Oidium lactis* was studied, were *Strept. lactis*, *Bact. coli* and *Bact. mesentericus*. There was no change in acidifying and clotting of milk by the acid bacteria, whether growing with or without *Oidium lactis*. The aroma which developed was rather unpleasant in the milk cultures of *Bact. mesentericus* together with *Oidium lactis*. The symbiosis promoted in an extraordinary way the longevity of the acid formers. The pH of the mixed cultures was increased in every case, when the *Oidium* had started its proteolytic and acid consuming activity. There was an intimate connection between the Eh-values and the logarithmic growth curves, but the influence of the symbiosis on the final values was very different.

K.J.D.

***Bacterium Bifidum* and *Thermobacterium Intestinale*.** S. ORLA-JENSEN
AND O. WINTHER, Royal Polytechnic Institute, Copenhagen, Denmark.
Zentr. f. Bact. 2, 93, p. 321, Feb., 1936.

Bact. bifidum is not, as Rettger and Weiss contended (1934), a variety of the intestinal bacillus, called *Acidophilus*. Furthermore *Thermobacterium intestinale* is not to be confused with *Bac. acidophilus* Moro. *Th. intestinale* may rather be confused with *Thermobacterium lactis*, but this organism almost always forms sharply edged colonies, produces pure l-lactic acid and is not stimulated by fecal extract. It is also easily differentiated from *Thermobacterium cereale*, because this organism does not live whether in milk nor in fecal material and is almost unable to ferment lactose.

K.J.D.

Sugar and Lactate Fermenting Butyric Acid Bacteria. J. VAN BEYNUM
AND J. W. PETTE, Agr. Exp. Station, Hoorn, Holland. Zentr. f. Bact.
2, 93, p. 198, Dec., 1935.

Only those butyric acid bacteria are dangerous for cheesemaking, which do not liquefy gelatin and are able to ferment lactate. Most of the examined strains have been isolated from milk by means of the Weinzirl test, acidifying the original milk by 2-3 cc normal sterilized lactic acid to 100 cc. The culture medium was autolyzed yeast plus 1.5 per cent sodium lactate (pH 5, 8-6, 0). It could be readily shown that there are non-liquefying strains, which ferment lactose and which do not, and that those strains, which ferment lactate, cannot ferment lactose and *vice versa*. The first group may keep the name "*Clostridium saccharobutyricum*" (including *Cl. butyricum*). For the second group the authors proposed the name "*Clostridium tyrobutyricum*," because only this group is important for cheesemaking. This group is not very active in carbohydrate splitting: regularly ferments only glucose and lactate, almost always levulose, sometimes galactose and arabinose. There is more butyric acid formation out of glucose by this group than by the first group.

That the first and not the second group causes the gassy butyric acid fermentation in cheese, could be shown experimentally. There is unfortunately no direct test for proving the existence of *Cl. tyrobutyricum* in milk and cheese. The indirect way is the following: The bacteria are enriched in glucose medium and afterwards inoculated into yeast autolysate plus lactate and peptone solution plus mannite. In the first medium only *Cl. tyrobutyricum* will grow, in the second one only *Cl. saccharobutyricum*. The Weinzirl test in the above mentioned modification is only a test on butyric acid bacteria as such, without differentiating between the two groups.

K.J.D.

Existence and Activity of Yeasts in the Milk. H. GLATHE, Univ. of Leipzig, Germany. *Zentr. f. Bact.* 2, 92, p. 61, April, 1935.

On a farm it was impossible to get butter even after 12 hours churning of the cream. A short time after beginning of churning the interior of the churn was filled with heavy foam. The bacteriological examination of the cream, which had an acidity of 0.135 per cent, revealed that the microflora consisted mainly of yeasts. True *Saccharomycetes* were determined to be the real cause of the fault. They were not further classified, however. The foaming was caused by the CO_2 -production of these *Saccharomycetes*. Their origin could be traced to the water in the barn which had been enriched by fruit-feeding.

K.J.D.

Experiments with Acid Formation. W. RITTER AND M. CHRISTEN. *Landwirtschaftliche Jahrbuch der Schweiz.* p. 749, 1935.

The authors found that with acid forming bacteria the production of lactic acid and acetone, and di-acetyl is not in a regular order. The same cultures may vary the amounts of each produced. Adding citric acid in small amounts stimulates acid and acetone development.

Hydrogen peroxide is produced in the presence of streptococci when air is injected into the culture or buttermilk but the activity in both is different.

W.R.

A Sequel to a Public Health Ruling Concerning Streptococci Mastitis.

C. S. BRYAN AND G. J. TURNEY, Mich. Agr. Exp. Sta., East Lansing, Mich. and Dept. of Health, Lansing, Mich. *Am. J. of Pub. Health*, 26, 5, p. 517, May, 1936.

The finding of streptococci of mastitis in the milk from 18 out of 20 dairies selling raw milk in the City of Lansing, Michigan, led to a Board of Health ruling that all raw milk sold in the City of Lansing must be produced by cows free from streptococci mastitis. Animals producing such raw milk must be tested every 6 months thereafter and found free of infectious mastitis. Any reacting animals must be removed from the herd. The author discusses the results which were obtained in detecting and eliminating infected cows from the herds.

M.W.Y.

Veterinary Service in the Control of Dairy Products. JOHN G. HARDENBERGH, V. M. D. Dir. of Lab, The Walker-Gordon Lab. Co., Inc., Plainsboro, N. J. *Am. J. Pub. Health* 26, 6, p. 597, 1936.

Veterinary service in the control of dairy products embraces wide and varied fields of activity which are discussed in this article. Some of the topics are (1) control of bovine diseases and safe milk; (2) official milk and dairy inspection service, and (3) industrial milk and dairy inspection service.

M.W.Y.

Attainable Standards in the Bacterial Counts of Raw and Pasteurized

Milk. M. E. BARNES, State Univ. of Iowa, Iowa City, Iowa. *Am. J. Pub. Health* 26, 6, p. 561, June, 1936.

The lack of adequate official supervision over the milk supply for the Children's Hospital and the surrounding community led to the organization of a University Department of Health. This paper summarizes the studies of milk production over 43 months during which a raw milk supply was greatly improved in quality as indicated by bacterial counts. On the basis of this performance, a bacterial count of 2,000 per cc was regarded as the upper limit of an ideal zone. Similar studies in pasteurized milk led to the use of maximum bacterial counts as the criterion of excellence, 1,000 per cc being regarded as the upper limit of the ideal zone. M.W.Y.

Differentiation of *Streptococcus pyogenes* from Man and Animals by the Sorbitol-Trehalose Test. F. C. MINETT. *J. Path. Bact.* 40, p. 357, 1935.

Examination of a series of *Streptococcus pyogenes* from the human body and from cow's milk gave support to the view that streptococci of this kind from man are trehalose fermenters, whereas those which may be found in cow's milk are ordinarily sorbitol fermenters. Considered in conjunction with the work of previous observers, the sorbitol-trehalose test appears to be a simple test of considerable value in establishing the original source of streptococci of this kind when present in milk. F.W.F.

Bovine Phthisis. Its Incidence in North-East Scotland. A. S. GRIFFITH AND J. SMITH. *Lancet*. 229, p. 1339, Dec. 14, 1935.

Bacteriological examinations of 103 cases of pulmonary tuberculosis revealed that in 13 instances tubercle bacilli of the bovine type could be found in the sputum. All strains were typical of the bovine strains in that they grew sparsely on media, and none showed the typical luxuriant growth of the human tubercle bacilli. In only 5 of these cases had there been a history of previous glandular tuberculosis. These 5 were considered to have been infected by milk from tuberculous cows. The source of infection in the other 8 cases was not determined. This series of cases of pulmonary tuberculosis has yielded the highest percentage of bovine infections yet recorded for this form of human tuberculosis, although this may have been due to chance grouping. J.A.T.

Undulant Fever. With Special Reference to its Clinical Aspects in England and Wales. W. DALRYMPLE-CHAMPNEYS. *Lancet*. 229, p. 1449, Dec. 28, 1935.

Of 255 undulant-fever patients in the author's series, 170 were males and 85 were females. Of 250 patients of known age, 107 were in the age

group between 30 and 40 years. The author believes that consumption of cow's milk is the commonest mode of infection, although in many instances the etiology is obscure. Where milk is *efficiently* pasteurized, as in London, the disease is almost unknown.

In discussing the clinical course and diagnosis of undulant fever, the author stresses the necessity and efficiency of the agglutination test, especially when a large range of dilutions is employed. In outlining treatment, vaccines are stated to be uncertain in effect, and drugs should be used sparingly. Diet and rest are important. The mortality is low, only 9 deaths having occurred in 290 cases. J.A.T.

Fifty Years of Progress in the Dairy Business. H. P. OLSEN, Milwaukee, Wisconsin. *Nat. Butter and Cheese J.* 26, 15, p. 28, August 10, 1935.

A brief historical review of the introduction of centrifugal separation of cream. Pictures of early creamery machinery are reproduced. W.V.P.

XVIII. A New Spectroscopic Phenomenon in Fatty Acid Metabolism. The Conversion of "Pro-Absorptive" to "Absorptive" Acids in the Cow. WILLIAM DAN, THOMAS MOORE, ROLAND G. BOOTH, JOHN GOLDING, AND STANISLAW K. KON. *Nutrition Lab., Univ. of Cambridge, England and National Inst. for Research, Univ. of Reading, England.* *Biochem. J.* 29, 138, 1935.

In previous work the authors have shown that when the cow is turned out to pasture after the winter, the fatty acids obtained from the butterfat show greatly increased absorption for radiation of wave-length 230 mu. Experiments were conducted, using various oils (sardine, cod-liver, linseed and rape oil) to determine the nature of the phenomena. The absorption of radiation at wave-length 230 mu by acids obtained from the oils (termed "pro-absorptive" acids) is small. When fed to cows the acids caused the butterfat to possess a much greater absorption in this region. When the fatty acids from the oils were subjected to prolonged saponification, they acquired a much greater absorptive property for radiation at 230 mu wave length. Thus certain acids from the oils may be converted from "pro-absorptive" or slightly-absorbing acids to "absorptive" or strongly absorbing acids either *in vivo* or *in vitro*. When the converted "absorptive acids" were fed cows, the absorption property of the butter acids increased rapidly. When, however, "pro-absorptive" acids were fed, and the butterfat acids then subjected to saponification, no further increase in absorption properties of the latter were noted. It seems probable the ingested "pro-absorptive" acids are either completely transformed into a strongly absorption substance or are not secreted into the milk. The nature of the change from slight to strongly absorbing acids is not known; it appears probable that the property

is confined to acids having two or more unsaturated linkages, and that intra-molecular rather than oxidative changes take place. K.G.W.

State Regulation of Bottled, Homogenized Milk. Milk Dealer, 25, 8, p. 36, May, 1936.

A survey, conducted by the Milk Dealer, in which they received word from 39 states and the District of Columbia, showed that of these states, Alabama, Arkansas, Iowa, Kansas, Maine, Massachusetts, Michigan, Missouri, New Hampshire, New York, South Carolina, Texas, Utah, Virginia, Wisconsin had no regulations on homogenized milk. California, Colorado, Connecticut, District of Columbia, Illinois, Indiana, Kentucky, Louisiana, Maryland, Minnesota, Montana, Nebraska, Nevada, New Jersey, New Mexico, North Dakota, Pennsylvania, Tennessee, and Washington permit the sale of homogenized milk, provided it is properly labeled. Florida and South Dakota had not been forced to rule on its legality, but did not look upon it with favor; and Georgia, Mississippi, North Carolina and Wyoming do not permit the sale of homogenized milk.

ICE CREAM

Recent Tendency Toward more Stringent Sanitary Requirements. H. H. SOMMER, Univ. of Wis., Madison, Wis., Ice Cream Field 28, 6, p. 9, April, 1936.

The realization that organisms causing diphtheria, scarlet fever, typhoid, septic sore throat and gastro-intestinal disorders, survive the freezing and storage temperatures in ice cream has done much to make the sanitary regulations strict. Recently the advent of the counter freezer has been an impetus to even more rigid requirements.

These regulations may involve the following:

- (1) Maximum bacterial counts,
- (2) Ingredients from inspected sources,
- (3) Pasteurization of flavors and colors,
- (4) Pasteurization under specified conditions,
- (5) Negative test for *E. coli* on the finished mix,
- (6) Precautions against recontamination after pasteurization,
 - (a) health of attendants
 - (b) sterilization of equipment
 - (c) freezing at the point where the mix is made and pasteurized.

It is suggested that nut cracking plants should be under supervision since contamination can occur as a result of human contact.

It is pointed out that equipment with which the ice cream comes in contact after pasteurization of the mix should effectively be sterilized and practical sterilization can be accomplished by the use of either steam, scalding hot water, or chemicals. W.C.C.

Flavor Defects in Ice Cream, their Causes, How to Remedy them. C. D. DAHLE, Penn. State College, State College, Pa. Ice Cream Field 28, 6, p. 12, April 1936; 28, 7, p. 18, May, 1936.

The main defects given on the ice cream score card are discussed from the point of view of cause and remedy. W.C.C.

Quick and Easy Ways of Turning out Fancy Brick Orders. J. O. LAITON. Ice Cream Field 28, 7, p. 9, May, 1936.

The author describes three ways of utilizing specially made core cutters in preparing center mold bricks. The basis of the method consists essentially in preparing bricks of ice cream, then cutting out the core as desired by the use of the core cutters while the ice cream is hard, and finally filling the core with a different kind of ice cream. W.C.C.

Materials for the Insulation of Ice Cream Plants and their Costs. F. B. FULMER. Ice Cream Field 28, 7, p. 10, May, 1936.

The author discusses some of the general requirements of materials for the insulation of ice cream plants. W.C.C.

What Quality Improvement can do for us. A. D. BURKE, Dairy Dept., Alabama Polytechnic Institute. Ice Cream Field 28, 4, p. 12, Feb., 1935.

The author points out that in the long run quality ice cream will win. In order to maintain high quality ice cream the following rules must be observed, he states:

(1) Process the mix according to fundamental principles of quality production, (2) Attain proper legislation to curtail the manufacture of cheap products at the same time providing reasonable and workable health regulations to protect the consuming public, (3) Maintain industry co-operation through trade associations, (4) Encouraging and profiting by ice cream judging contests and exhibits. W.C.

Proper Storage Temperature of Frozen Fruit. J. C. HENING, New York Agr. Exp. Sta., Geneva, N. Y. Ice Cream Field 26, 3, p. 22, Jan., 1935.

The author concludes as a result of experiments in freezing and storing strawberries and raspberries for use in ice cream, that storage at 0° F. is preferable to storage at 15° F. to 18° F. as recommended by certain other workers; especially is this true if the fruit is to be held in storage from season to season. W.C.

The Construction and Maintenance of the Cold Room. C. D. DAHLE, Penn. State College, State College, Pa. Ice Cream Field 28, 2, p. 12, Dec., 1935.

The author sketches the evolution of the methods used in hardening ice cream, mentioning the following as being important developments: brine boxes, ice cream cabinets, still-air hardening rooms, gravity system refrigerator rooms. When the capacity of a plant reaches 50 to 75 gallons of ice cream per day, a hardening room is recommended. It is suggested that 9 to 10 inches of cork insulations be used for hardening rooms and 4 inches for milk storage rooms.

Although direct expansion ammonia refrigeration is generally practiced, where extremely low temperatures (-40° F. to -50° F.) are required the carbon dioxide compressor may be used. It is a matter of conjecture, whether it pays one to use temperatures as low as -30° F. to -40° F. in order to harden package ice cream in 30 to 40 minutes, if one can harden the same packages in 2 to 3 hours at a temperature of -15° F. with the use of fans or blowers. It is pointed out that the use of fans to aid in rapid freezing is a less expensive method than attempting to do this with extremely low temperature without circulation of air, and instances are cited where by this method under commercial conditions the hardening time has been decreased one half or more.

It was found that pint samples hardened in $1\frac{1}{4}$ hours were only slightly smoother than those hardened in $2\frac{1}{2}$ hours, whereas those hardened in 10 hours were criticized as being coarse. It is reported that increasing the drawing temperature 2.4° F. increases the hardening time 4.05 hours and decreased by one point the score on body and texture.

It was observed that small packages harden more quickly than do larger containers, but the difference in texture often favors bulk ice cream because of improper filling and handling of the packages.

W.C.C.

Defects of High-solids Mixes and their Cure. M. J. MACK, Mass. State College, Amherst, Mass. *Ice Cream Field* 27, 3, p. 24, July, 1935.

The author reports a series of investigations with ice cream mixes containing from 16 to 25 per cent butterfat, the majority of which contained from 18 to 20 per cent butterfat. With this type of mix the following defects may be expected: (1) excessive viscosity which interferes with efficient homogenization, cooling, freezing and packaging; (2) unsatisfactory melting appearance; (3) a crumbly body which makes serving of the ice cream difficult. The author discusses the means used to overcome these defects and summarizes the results as follows:

1. High-solids ice cream mixes, when made under usual processing conditions, are excessively viscous and produce crumbly ice cream possessing an undesirable melting appearance.

2. The use of butter, frozen cream or plastic cream in place of all or a part of the sweet cream needed to supply the butterfat markedly increases these defects.

3. The use of three successive stages of homogenization entirely eliminates the problem of excessive viscosity and decreases the other defects already named. Pressures of 2,000, 500 and 150 pounds are suggested as satisfactory maximum pressures for the first, second and third valves, respectively, when homogenizing an 18 per cent butter fat mix. With a 20 per cent fat content, somewhat lower pressures of 1,500, 500 and 150 pounds are suggested as maximum pressures.

4. A crumbly body may be prevented in high-butterfat ice creams by increasing the sugar content to 16–17 per cent, depending somewhat upon the fat content of the mix. If the use of cane sugar alone produces an excessively sweet taste, the substitution of corn sugar for 3–4 per cent of the cane sugar is recommended.

5. Increasing the sugar content to 16–17 per cent improves the melting appearance of high-fat ice creams and reduces the melting resistance of such ice creams.

6. Three-stage homogenization entirely eliminates the excessively high viscosity which invariably occurs in chocolate ice cream mixes of high solids content.

Editors' note: High-solids mixes refers to high-fat mixes in this article.

W.C.C.

New Developments in the Homogenization of Ice Cream Mix. H. H. SOMMER, Dairy Dept., Univ. of Wis., Madison, Wis. *Ice Cream Rev.* 18, 12, p. 48, July, 1935.

The efficiency of homogenization involves two considerations: (1) the size of the globules to which the fat has been subdivided, and (2) the clustering or non-clustering of the globules. The size of the globules that are present in the product after homogenization depends on a number of factors enumerated as follows:

1. The coarseness or fineness of the original emulsion.
2. The fat concentration in the product being homogenized.
3. The temperature of homogenization.
4. The valve clearance in the homogenizing valve.
5. The design of the valve.
6. The homogenizing pressure.

Large clusters of globules are almost as detrimental to whipping ability, body, and texture as large globules. The factors which affect clustering are:

1. The fat concentration.
2. Homogenizer valve conditions—design and whether one, two, or three stages.
3. Homogenizing pressure and temperature.
4. The presence of sugar, gelatin and egg yolks.
5. The effect of salts and reaction.

The effect of a number of these factors on clustering can be explained on the basis of the charge on the globules, on the theory that a high charge tends to keep the globules apart by mutual electrostatic repulsion. J.H.E.

Technical Control of Ice Cream with Sodium Alginate. CLARK GOODMAN, Kelco Co., San Diego, California. *Ice Cream Rev.* 18, 7, p. 42, Feb., 1935.

The author reports that a vegetable stabilizer manufactured from kelp and technically known as sodium alginate gives satisfactory stabilization of ice cream. Experimental and commercial data are presented comparing sodium alginate with gelatin in similar ice cream mixes. The amounts of stabilizers used were 0.3 per cent gelatin (250 Bloom strength) and 0.25 per cent sodium alginate.

The organoleptic tests for texture were supplemented with photomicrographs. Sodium alginate is said to possess superior texture improving qualities. Accelerated exposure tests made by transferring 2½ gallon samples of sodium alginate ice cream back and forth every 24 hours between two cabinets, one maintained at 16° to 18° F., the other at 4° to 6° F., for ten days also demonstrated the efficacy of sodium alginate as an ice cream stabilizer.

Data are presented comparing the whipping time of sodium alginate and gelatin mixes in a batch freezer. Mixes containing the sodium alginate were found to whip to 100 per cent overrun in slightly less time than similar mixes containing gelatin. Melting tests of the ice creams showed the sodium alginate ice cream to melt faster than the gelatin product. J.H.E.

Sandiness: Its Causes and Prevention. G. L. GIBSON. *Ice Cream Field* 27, 1, p. 28, 2, p. 28, May and June, 1935.

The following points were given major consideration in the study: (1) The use of special concentrated skimmilk products to increase the serum solids content above normal; (2) Influence of pasteurization temperature upon the development of sandiness; (3) Relation of fat clumping to lactose crystallization. Organoleptic methods of comparison were used throughout the experiments as a basis of determining the occurrence of sandiness. The following conclusions are drawn:

1. Increasing the serum solids above that normally occurring in ice cream with either Hi-Solids, Pro-Lac, Kraftogen B.D. or regular skimmilk powder lowered the minimum temperature and increased the time required to whip the ice cream to 100 per cent overrun.

2. Adding Hi-Solids or skimmilk powder at the freezer resulted in an uneven distribution of the powder throughout the ice cream. There was a tendency for more of the products to be in the first portion of the ice cream drawn from the freezer than in later portions.

3. Increasing the serum solids above that normally occurring in ice cream decreased the heat resistance of the ice cream.

4. The special concentrated skimmilk products studied did not improve the flavor of ice cream. Pro-lac powder produced a "malt" flavor and it also made the ice cream taste salty. In all cases a milk powder flavor was noted in ice creams containing increased serum solids. Hi-Solids milk powder produced an ice cream a flavor comparable to that imparted by high-quality skimmilk powder.

5. The special concentrated milk products studied, except Pro-Lac, improved the body of the ice cream. A spongy and somewhat sticky body occurred when Pro-Lac powder was used to build up the serum solids in ice cream. Too much Hi-Solids (6 per cent or more) produced a dry, powdery body. Skimmilk powders prepared by the spray and vacuum roll processes gave results similar to those of Hi-Solids when added at the freezer. The atmospheric roll type of skimmilk, on the other hand, caused the ice cream to be dry and rough.

6. Under commercial conditions, where temperature fluctuations were slight and the turnover quite rapid, it was found that the special concentrated skimmilk products studied could be used to build up the serum solids in ice cream without much danger of sandiness developing. However, under severe storage conditions, the ice creams containing added solids became sandy sooner than ice creams with normal percentages of serum solids. Ice cream containing regular skimmilk powders became sandy sooner than those to which Hi-Solids had been added. Both Pro-Lac and Kraftogen B.D. proved slightly better than Hi-Solids in this respect.

7. Lactose crystallization in ice cream was not materially retarded by pasteurizing the milk between 160° F. and 175° F. when compared to 145° F.

8. Clumping of the fat globules in ice cream, induced by adjusting the homogenizing pressure and temperature, did not seem to delay lactose crystallization.

W.C.C.

A Survey of the Age and Condition of Package Ice Cream as Bought by the Consumer. A. C. SCHRICKER, St. Louis Dairy Co., St. Louis, Mo. *Ice Cream Rev.* 18, 7, p. 34, Feb., 1935.

A survey of the flavor, body, age, and appearance of package ice cream as bought by the consumer representing six months of study by the Missouri Ice Cream Manufacturers' Association's Research Committee. Packages of different brands were purchased from different dealers, at ten-day intervals and scored by members of the research committee. The survey was limited to two types of combination packages, the neapolitan package and a special featured by the various manufacturers. It was found that in a combination

package of ice cream its quality is no better than its weakest flavor, which in the case of neapolitan was strawberry. The body of the ice cream in most of the packages was found to be good.

The age of most of the packages could be identified because of code. The age of each group investigated was classified. Of the neapolitan packages picked up, 5.7 per cent were known to be only a week old, 31.4 per cent two weeks old, 17.1 per cent three weeks old, 11.5 per cent four weeks old, 11.5 per cent five weeks old, and 22.8 per cent of which the age could not be determined. In the special feature package, 22 per cent were a week old, 48.2 per cent were two weeks old, 14.2 per cent three weeks old, and 4 per cent age unknown.

The appearance of 77.2 per cent of the neapolitan packages picked up was scored as good, 22.8 per cent being soiled. In the special packages 85.2 per cent scored good, and 14.8 per cent were soiled. Eighty-eight per cent of the packages picked up were firm, and 12 per cent were quite soft.

The findings of the committee bring out the importance of age in governing the quality of ice cream reaching the consumer. J.H.E.

Dry Egg Yolk for Ice Cream. J. H. ERB, Dept. of Dairy Tech., Ohio State Univ., Columbus, Ohio. *Ice Cream Rev.* 18, 8, p. 41, March, 1935.

Seven brands of dried egg yolk as used in ice cream were subjected to a number of laboratory tests to indicate their purity, freshness and solubility. The various samples were also incorporated in ice cream mixes to the extent of 0.4 per cent and the whipping time of each mix carefully noted. The test mixes were made from sweet butter, skimmilk powder and water. Such a mix whipped poorly without the addition of egg yolk. The beneficial effects imparted to the whipping of such a mix varied with the different brands. The poorest product was found to contain a "filler." No one exact laboratory test was found whereby the effectiveness to produce whipping in the mix could be measured.

The effect on flavor of ice cream varied with the freshness of the egg yolk. The free fatty acid number, and the pH of the dried yolk was found to be indicative of freshness and quality. The acidity of the fat in good quality material was within the range of 2.0 to 3.5 c.c. The pII of the same samples was within the range of 6.5 to 6.7.

Fat including lipoids, in the pure products, ranged from 58 to 62.34 per cent. Moisture of fresh samples came within the range of 3.87 to 5.54 per cent. J.H.E.

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ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

BUTTER

The Relative Vitamin A Potency of Carotene Fed in Butter Fat and Cottonseed Oil. HENRY R. KRAYBILL AND CHARLES L. SHREWSBURY, Purdue, Univ. Agr. Exp. Sta., Lafayette, Ind. *J. Nutrition* 11, p. 103, Feb., 1936.

Treatment of melted butter fat with Lloyd's reagent removes the natural yellow pigments and vitamin A without noticeable destruction or removal of the natural antioxidants.

Hydroquinone in amounts as high as 100 mg. per 100 gm. of oil does not seriously interfere with the utilization of carotene from cottonseed oil.

Carotene dissolved in butter fat decolorized with Lloyd's reagent is not utilized as well as when it is dissolved in cottonseed oil. Two to three times as much carotene are required to give equal vitamin A potency when fed in butter fat decolorized with Lloyd's reagent as when fed in cottonseed oil.

L.A.M.

The Effect of Feeding Cacao Shell to Cows on the Vitamin D Content of Butter (Milk). S. K. KON AND KATHLEEN M. HENRY, National Inst. for Res. in Dairying, Univ. of Reading. *Biochem. J.* 29, p. 2051, 1935.

Cacao shell, an important by-product of chocolate manufacture, is rich in vitamin D. According to curative and preventive tests for vitamin D, cacao shell used in the feeding experiments contained an average 35 I.U. of vitamin D per gram, while the cacao shell fat, which carries about 40 per cent of the total activity of the cacao shell, contains about 300 I.U. of vitamin D per gram. The latter was about one-quarter as potent as an average cod-liver oil. A basal ration was fed four cows in winter stall feeding experiments for a pre-experimental period lasting January 8 to February 8, when for the experimental period lasting until March 17, two of the cows were each fed in addition, cacao shell increasing in amounts from one half to two pounds. An examination of the butter obtained from the milk during the experiment showed, for the control butter fat, 0.20 I.U. per gram during the pre-experimental period, and 0.21 I.U. per gram during the experimental period, whereas the "Cacao shell" butter fat showed, respectively 0.17 and 0.51 I.U. per gram. The feeding of cacao shell increased the vitamin D content of the butter fat from 2.5 to 3 times. When feeding two pounds of cacao shell per day (containing 32,000 I.U. of vitamin D) to cows on a winter ration, the vitamin D content of the butter fat is raised from a winter to a summer level.

K.G.W.

Some Practical Studies in the Cold Storage of Butter. L. C. THOMSEN, Dept. of Dairy Ind., Univ. of Wis., Madison Nat. Butter and Cheese J. 26, 15, p. 30, Aug. 10, 1935.

Good cream and proper pasteurization are essential for cold storage butter. Recent tests show the effect of various woods for tubs and boxes on the flavor and odor of storage butter. The southern hardwoods tested are listed in order of preference:—Ash, soft maple, hackberry, sycamore, beech, yellow poplar, elm, black gum, basswood, cottonwood, red gum, and magnolia. Paraffining was of no advantage when the tubs were used for the storage of butter.

In a limited number of trials different materials used for wrapping butter were satisfactory in dark storage but in daylight (not sunlight) they protected butter from the development of oxidized flavor in the following order of effectiveness:—Coated aluminum foil; dark green, non-waterproof cellulose; cellulose with light-filtering MRT; parchment wrapped in carton; dark blue, non-waterproof cellulose; dark red non-waterproof cellulose; Kerr glass jar; waterproof cellulose; tango, non-waterproof cellulose; rubber film; pink non-waterproof cellulose; and parchment. Temperature of storage was 40° F. The butter in the best wrapper showed no oxidized flavor in one week while that in the least protective wrapper was very objectionable after three days.

W.V.P.

The Effect of Certain Factors upon the Keeping Quality of Butter. E. S. GUTHRIE, B. J. SCHEIB AND C. N. STARK, Lab. of Bact., N. Y. State College of Agr., Cornell Univ., Ithaca, N. Y. JOURNAL DAIRY SCIENCE 19, 4, p. 267, April, 1936.

The effect of milk enzymes, bacteria, acid and salt on the keeping quality of butter stored at relatively high temperatures has been studied and reported in this paper.

A.C.D.

Effect of Lipolysis on the Churnability of Cream Obtained from the Milk of Cows in Advanced Lactation. V. N. KRUKOVSKY AND PAUL F. SHARP, Dept. of Dairy Industry, Cornell Univ., Ithaca, N. Y. JOURNAL DAIRY SCIENCE 19, 4, p. 279, April, 1936.

The authors conclude that difficult churnings of cream due to cows in advanced lactation are caused directly by lipase. Prompt pasteurization of the milk or cream immediately after production prevents this difficulty in churning.

A.C.D.

The Relation of the Amino Nitrogen Content to Quality of Cream and Butter. H. D. JACOBSEN, Dept. of Dairy Husb., So. Dakota State College, Brookings. JOURNAL DAIRY SCIENCE 19, 2, p. 125, February, 1936.

The authors conclude that the amino nitrogen content of cream may be of aid in cream grading when used in conjunction with other tests.

A.C.D.

A Study of Fat Splitting and Casein Digesting Bacteria Isolated from Butter. C. N. STARK AND B. J. SCHEIB, Lab. of Bact., N. Y. State College of Agr., Cornell Univ., Ithaca, N. Y. *JOURNAL DAIRY SCIENCE* 19, 3, p. 191, March, 1936.

The authors isolated and studied the characteristics of various fat splitting and casein digesting bacteria from butter. New names were suggested for five species.

A.C.D.

Irradiation of Fats. I. A Standardized Method of Use of Ultra Violet Light. LESLIE H. LAMPITT, NORMAN D. SYLVESTER AND PHILIP BILHAM, Lyons Laboratories. *Biochem. J.* 29, p. 1167, 1935.

The examination of the influence of light on fats and oils necessitate standard methods of evaluating the chemical changes, correlation of these results with observations of taste and smell, and a defined technique whereby figures representative of the energy of the light acting on the sample under observation can be obtained. A method is described whereby the total radiation from an electric arc applied to a sample under examination is measured by use of a photo-electric cell placed in a position other than that occupied by the sample. The method is applicable to the examination of other products wherein a knowledge of the effect of measured radiation on various properties is desired.

K.G.W.

CHEESE

Bitter Flavor in Cheddar Cheese. WALTER V. PRICE, Univ. of Wis., Madison. *JOURNAL DAIRY SCIENCE* 19, 3, p. 185, March, 1936.

The bitter flavor which sometimes develops in cheddar cheese was found to be due to the development of a slight excess of acid in the finished cheese as a result of too much acid development during the manufacturing process.

A.C.D.

Curd Tension of Milk and its Relationship to Firmness of Curd in Cheesemaking. G. P. SANDERS, K. J. MATHESON, AND L. A. BURKEY, Bureau of Dairy Industry, U. S. Dept. of Agr., Washington, D. C. *JOURNAL DAIRY SCIENCE* 19, 6, p. 395, June, 1936.

The Hill curd test was not applicable for determining the firmness of the curd produced in milk during cheesemaking.

A.C.D.

CONCENTRATED AND DRY MILKS

The Retentions of Nitrogen, Calcium, Phosphorus of Infants Fed Sweetened Condensed Milk. H. E. HARRISON. *J. Ped.* 8, p. 415, April, 1936.

Metabolism tests reported by the author on infants fed on sweetened condensed milk do not support the commonly expressed belief that this product is an inadequate food for infants because of a low content of protein. On the contrary, the protein requirements of infants apparently were satisfied when they received 10 per cent of their calories in protein from sweetened condensed milk formulas, and the total intake of calories was adequate.

J.A.T.

The Antirachitic Value of Irradiated Evaporated Milk and Irradiated Whole Fluid Milk in Infants. (An in-patient study). M. RAPOPORT AND J. STOKES. *J. Ped.* 8, p. 154, Feb., 1936.

Nineteen white infants under three months of age were selected for the study reported in this paper. All the infants lived in the hospital during the study. Ten of these infants were given irradiated evaporated milk and nine irradiated whole fluid milk. The two milks were practically equal in vitamin D content, the average daily intake for the evaporated milk group being 123.9 U.S.P. units daily, and for the fluid milk group 122.4 U.S.P. units daily.

During the 4½ months of the study no roentgenographic evidences of rickets appeared. Both milks were found to be equally efficacious in preventing the development of rickets. One infant showed evidence of mild rickets at the beginning of the study. Healing began in 13 weeks and was complete in 18.

J.A.T.

Irradiated Evaporated Milk in the Prevention of Rickets. T. G. H. DRAKE, F. F. TISDALL AND ALAN BROWN. *J. Pediatrics* 8, p. 161, Feb., 1936.

Irradiated evaporated milk was given to 103 infants over a period of five winter months. The degree to which rickets developed in this group was compared with that observed in another group of 104 infants, half of whom received plain evaporated milk and the other half pasteurized whole milk.

In the group receiving irradiated evaporated milk the x-ray showed no cases of moderate or marked rickets. Seventeen per cent showed mild rickets but of such a slight degree as to be of no clinical importance, and all showed evidence of healing.

Of the 52 infants receiving evaporated milk with no vitamin D at the end of the period of study, 10 per cent developed x-ray evidence of moderate or marked rickets and 29 per cent showed mild rickets.

X-ray showed development of rickets to a moderate or marked degree in 28 per cent of the pasteurized milk group and mild rickets in 25 per cent of this group.
J.A.T.

The Age Thickening of Sweetened Condensed Milk. V. C. STEBNITZ AND H. H. SOMMER, Dept. of Dairy Industry, Univ. of Wis., Madison.
JOURNAL DAIRY SCIENCE 19, 2, p. 101, February, 1936.

The salts of milk were found to have an important effect upon the stability of sweetened condensed milk and sodium citrate was particularly efficient in stabilizing sweetened condensed milk which normally tended to thicken greatly during storage.
A.C.D.

Nutritional Anemia in Rats Alleviated by Evaporated Milk and Iron. HERMAN B. STEIN, MORTON H. RADETSKY AND ROBERT C. LEWIS, Dept. of Ped. and Biochem. of the Univ. of Colorado School of Med., Denver.
JOURNAL DAIRY SCIENCE 19, 2, p. 117, February, 1936.

The author found that the copper content of evaporated milk was sufficiently great to prevent nutritional anemia in rats when supplemented by iron alone.
A.C.D.

Condensed Milk and Milk Powder. OTTO FREDERICK HUNZIKER. Fifth Edition, pages 661, year 1935. Published by the author, La Grange, Illinois. Price \$6.50.

Condensed Milk and Milk Powder has been carefully revised at frequent intervals since it made its appearance in 1914. The need for the present rewriting and enlarging is not only due to the rapid development in certain fields of science and in practice but must also be to a considerable extent to the desire to keep an acknowledged leading text in that recognized position by constant revision.

The author has kept the needs of the industry foremost in mind and has presented the scientific knowledge and theories with ample detail for a thorough understanding of their technical application.

In addition to presenting new material in the previous chapters, the book has also been altered by new chapters and the omission of some subjects discussed in previous editions. The chapter on packing condensed milk in vacuum has been omitted in this fifth edition. There is a new chapter on the "use of corn sugar in sweetened condensed milk," on the "manufacture of sterilized sweet cream," on "dough-and-film drying," and on the "manufacture of milk sugar."

For those not familiar with earlier editions of this book it is well to illustrate its extensive nature by the subjects covered in Part 6 on the "Manufacture of Milk Powder." There are chapters dealing not only with various phases of dry milks but also with dried buttermilk, dried whey, malted milk, and milk sugar.
A.C.D.

ICE CREAM

The Effect on Quality of the Age of the Package. A. C. SCHRICKER, St. Louis Dairy Co., St. Louis, Mo. *Ice Cream Field* 26, p. 18, Jan., 1935.

Some of the results of a survey made by the research committee of the Missouri Association are given in this report.

It is stated that vanilla ice cream of high quality was found to show the effects of age within four weeks from the date of manufacture, whereas chocolate ice cream required from four to six weeks while strawberry ice cream showed comparable deterioration within two weeks. Since the quality of a combination package of ice cream is no better than the worst flavor, the length of time a package of Neapolitan ice cream remains salable depends primarily on the quality of the strawberry ice cream it contains.

It is concluded that there is a direct relationship of age to quality of the ice cream, and further that the greater the percentage of old packages the greater the percentage of poor flavors. This emphasizes the value and importance of quick turnover both in the hardening room and the dealer's cabinet. W.C.

MILK

Revised Milk Designations. *Lancet* 230, p. 1036; The New Grades of Milk. Edit. 230, p. 1016, May 2, 1936.

Grading of milk was introduced in Great Britain in 1923, when Certified, Grade A (tuberculin-tested), Grade A, Pasteurized, and Grade A (pasteurized) were the designations permitted. Producers were, however, not required to conform to the standards for these grades and much milk has been sold to the public as undesignated.

On June 1, 1936, there was put into effect a New Milk Order, which provides for three grades: Tuberculin-tested, Accredited, and Pasteurized, although additional descriptions may be added by producers who are suitably qualified. Thus, there may actually be the following:

Tuberculin-tested (certified)
Tuberculin-tested (pasteurized)
Tuberculin-tested
Accredited (farm bottled)
Accredited
Pasteurized

and, of course, says the *Lancet*, undesignated milk.

Certified milk must not contain more than 30,000 bacteria per cc. Tuberculin-tested must not exceed 200,000, although after the end of the year, the bacterial plate count will be replaced with a methylene-blue reduction test. In addition, no coliform bacilli should be found in 0.01 millilitre. Tubercu-

lin-tested (pasteurized) must contain less than 30,000 organisms per millilitre. Accredited milk is raw milk from herds examined by a veterinarian every three months, and the milk must pass the same methylene-blue test as the Tuberculin-tested milk.

The *Lancet* does not consider this "accredited milk" a satisfactory product, and states editorially that the public will find safety chiefly in efficient pasteurization.

J.A.T.

Effect of Tankage on the Flavor of Milk. T. M. OLSON, C. C. TOTMAN AND L. C. WALLIS, So. Dakota State College, Brookings. *JOURNAL DAIRY SCIENCE* 19, 5, p. 313, May, 1936.

The feeding of very high proportions of tankage in the grain rations of cows has no effect upon the flavor of milk.

A.C.D.

Corn Gluten Feeding and the Titratable Acidity of Milk. ELMER O. ANDERSON, GEORGE C. WHITE AND ROBERT E. JOHNSON, Storrs Agr. Exp. Station, Storrs, Conn. *JOURNAL DAIRY SCIENCE* 19, 5, p. 317, May, 1936.

Contrary to popular opinion in certain sections of this country, the feeding of corn gluten feed in the ration of dairy cows did not affect the titratable acidity of the milk.

A.C.D.

Observations on the Freezing of Milk and Cream. II. The Destruction of the Fat Emulsion in Frozen Cream. F. J. DOAN AND F. BRUCE BALDWIN, JR. Penn. Agr. Exp. Sta., State College, Pa. *JOURNAL DAIRY SCIENCE* 19, 4, p. 225, April, 1936.

This study deals with various factors involved in the freezing of cream which affect the stability of the butterfat emulsion and of the proteins.

A.C.D.

Some Factors Influencing the Acidity of Freshly Drawn Cows' Milk. W. J. CAULFIELD AND W. H. RIDDELL, Kan. Agr. Exp. Sta., Manhattan. *JOURNAL DAIRY SCIENCE* 19, 4, p. 235, April, 1936.

The authors conclude that the acidity of fresh cows' milk is affected principally by the breed of cows, individuality of the cow and the stage of the lactation period.

A.C.D.

Butterfat and Total Solids in New England Farmers Milk as Delivered to Processing Plants. MOSES S. JACOBSON, Lab. of the Whiting Milk Co., Botson, Mass. *JOURNAL DAIRY SCIENCE* 19, 3, p. 171, March, 1936.

The fat and milk solids-not-fat was determined in more than 100,000

samples of milk produced in New England and the results were presented to establish a general relationship between these constituents. A.C.D.

Milk Production and Control. WM. CLUNE, HARVEY AND HARRY HILL. Medical Officer, and Sanitary Inspector, Public Health Department, Town Hall, Palmers Green, N. 13, England, pages 556, illustrations 180, year 1936. Published by H. K. LEWIS AND CO., 136 Gower St., London. Price 214. Net.

The scope of this new book is clearly stated by the authors in the preface. The milk supply of England "affects every class of the community" and "no industry plays a more important part in the natural life of today." The authors present the general field of fluid milk production and control as it exists today in all its aspects.

The various chapters are as follows: Composition of milk, milk and disease, the cow, the cowshed, the dairy, clean milk production, the distribution of milk, designated milks, treatment of milk by heat, laboratory and other control, legislative control, future of the milk industry, and appendix.

For American readers this book has a special value in presenting a rather complete picture of the production, handling, and inspection of fluid milk from the English viewpoint. There are certain definite tendencies to stress some problems in England to which less attention is given in America and certain problems which are thought to be so important here are given minor consideration in England. A.C.D.

Fundamentals of Dairy Science. ASSOCIATES OF LORE A. ROGERS, Bureau of Dairy Industry, United States Department of Agriculture, Washington, D. C., pages 616, Second Edition, 1935. American Chemical Society Monograph Series No. 41, Published by Reinhold Publishing Corp., 330 West Forty-Second St., New York, N. Y. Price \$5.50.

A book for the "advanced student and research workers in the field of dairy science" needs frequent revision. It is gratifying therefore that the authors have brought *Fundamentals of Dairy Science* up-to-date by a second edition within seven years of the first edition. In the preface it is stated that "knowledge of certain topics—*e.g.*, pigments, vitamins—is advancing so rapidly that, by the time this edition is published, some parts will already be in obvious need of further alteration and additions."

The organization of subject matter has not been changed, the book being divided with four parts dealing with the constituents of milk, the physical chemistry of milk and milk products, the microbiology of milk and milk products, and the nutritional value of milk and milk products grouped together with a chapter on the physiology of milk secretion. It is evident that much of the book has been completely rewritten and the net results of additional new material less that deleted is a gain of 73 pages.

The reviewer believes that students of dairy science are very appreciative of the work of the many authors who have incorporated the results of recent fundamental studies in this valuable book. A.C.D.

Variations in Serum-Magesium and in Partition of Serum-Calcium in Normal Parturition and in Milk Fever. WILLIAM GODDEN AND JOHN DUCKWORTH, Rowett Research Institute, Aberdeen. *Biochem. J.* 29, p. 445, 1935.

In a study by the authors, determinations were made of serum-magnesium, serum-calcium, adsorbable and non-adsorbable calcium complexes of the serum of blood taken from nine cows prior to and after calving. Three of the cows exhibited typical symptoms of milk fever, three were abnormal cases with some signs of milk fever associated with other complications, and three were normal calvings. Generally, a normal rise in serum-magnesium was observed at calving in all three groups. In the milk fever cases a slight fall in serum-magnesium was observed followed by a definite rise persisting during the milk fever stage. A decline of serum calcium at parturition of all animals was observed, but the decline in the blood of these animals which subsequently developed milk fever was much more rapid and more extensive. A fall in the calcium complexes accounted for the major part of the fall in total serum-calcium in cases of milk fever. It appears that the symptoms of true milk fever only become acute when the values for both adsorbable and non-adsorbable calcium are simultaneously at low levels and near to their minima. With normal cases the value of the calcium complexes was lowest at about the time of calving. During recovery from milk fever-magnesium and serum-calcium rise together. K.G.W.

The Prevention of Rickets with a Cod Liver Oil Concentrate in Milk. M. G. PETERMAN AND ELY EPSTEIN. St. Vincents Infants Asylum and Dept. of Pediatrics, Marquette Univ. School of Med., Milwaukee, Wis. *Am. J. Diseases of Children* 50, p. 1152, Nov., 1935.

This report concerns the use of a standard evaporated whole milk, fortified with cod liver oil concentrate during the evaporating process, in the prevention of rickets. It also includes a study of the prevention of scurvy in the same infants by the use of canned ripe pineapple juice as the sole source of vitamin C.

Each infant received from 8 to 17 ounces of the evaporated milk per day. This provided from 228 to 485 U.S.P. units of vitamin D and an additional supply of from 1142 to 2428 units of vitamin A in the added concentrate. From 1 (up to 6 months of age) to 2 ounces of pineapple juice were fed daily. A group of twenty-six infants in the susceptible age period for the development of rickets was studied from periods of from four months to thirteen and a half months (twenty infants).

Five infants had some questionable clinical signs of rickets early in the period. There were no positive roentgenographic findings and the clinical and chemical findings became normal and remained so throughout the period. All of the infants made normal gains in weight and length during the period of study. There were no signs of scurvy. W.H.R.

Physiological Bases of Nutrition. Report of a technical committee of the League of Nations. *Lancet* 229, p. 1434, Dec. 21, 1935.

That deficiency in important nutrients is a common feature of the average diet and that such deficiencies are more commonly found in the protective foods rather than in the energy-yielding foods—are the conclusions of the Technical Commission of the Health Committee of the League of Nations, in a report published in Geneva.

In the first part of this report, energy requirements of different age and occupational groups are discussed, including sources of protein, fat and calories.

The second part deals with the protective foods—"first and most important of which," it is stated, "are milk and milk products, eggs and glandular tissues." Green leaf vegetables, fruits, fat fish, and meat (muscle) are also essential. The requirements of children and mothers, as well as other adults are discussed.

It is the opinion of the Commission that, "Milk should form a conspicuous element of the diet of all ages," and the report goes on to commend the tendency in some countries to encourage and provide increasing amounts of milk for pregnant and nursing women, as well as for children.

The value of skimmed or separated milk is not sufficiently recognized, the Commission believes, and it should be used far more extensively than it is, as a source of minerals, protein, calcium and vitamins B and C. Only vitamin A is reduced with the removal of the fat.

Milk is a rich source of calcium salts and phosphates, of vitamins B₂ and B₁. The calcium salts and phosphates are valuable in increasing the effect of vitamin D from whatever source. Although poor in iron itself, milk renders more effective the iron provided by other foods in the diet.

J.A.T.

Prevention of Dental Caries and the Improvement of Health by Dietary Means. F. F. TISDALL. *Pa. Med. J.* 39, p. 149, Dec., 1935.

Little is known, even after the extensive studies of recent years, regarding the actual causes of dental caries. It is definitely known, however, that an adequate, well-balanced diet is an important factor in reducing, if not actually preventing tooth decay. Numerous studies of children receiving daily diets of at least 1½ pints of milk, meat, vegetables, eggs, fruits and supplementary vitamin D have shown that dental caries may be definitely

arrested. Whether such diets act by changing the resistance of the tooth itself, the composition of the saliva, or by reducing the carbohydrate in the diet is not entirely understood, but in the words of the author, "the fact remains, beyond any doubt that the administration of this type of diet does decrease tooth decay." J.A.T.

Milk As a Source of Vitamin C. *Science* 83, p. 162, Feb. 14, 1936.

A note from the Kansas Agricultural Experiment Station refers to 502 tests of the vitamin C content of milk from 55 cows representing the four major dairy breeds—Holstein, Jersey, Guernsey and Ayrshire. An average value of 25.9 mg. of vitamin C per liter of milk was obtained. A range of 19 to 27 mg. of vitamin C daily has been suggested as the human minimum requirement.

These authors believe that much of the vitamin C content can be preserved in raw milk or in milk pasteurized by the flash method if proper care is exercised. J.A.T.

Study of the Committee on Clinical Investigation and Scientific Research of the American Academy of Pediatrics. 1935. *J. Ped.* 8, p. 124, Jan., 1936.

Because vitamin D is essential during infancy, and only slightly less important during adolescence, pregnancy and lactation, the high cost of sources of vitamin D has been made the subject of investigation by a committee of the American Academy of Pediatrics.

In particular, the control of vitamin D sources, other than cod liver oil, by the Wisconsin Alumni Research Foundation was investigated, since this foundation owns the patents, and grants licenses both to the manufacturers of vitamin D and to food companies desiring to add this factor to their products.

Milk, bread and cereals are, according to the Foundation, the most logical foods to which vitamin D should be added. There are 135–140 licenses for irradiated fluid milk, 5 licenses for irradiated evaporated milk, and 220–225 licenses for metabolized (yeast fed) milks.

It was found by the investigators that the higher price charged for vitamin D milks over other milks, was not the result of the royalties paid to the Wisconsin Alumni Foundation but rather was necessitated by state and local regulations and other factors controlling the price of milk.

It soon became evident, according to the reporting committee, that the question was of much wider scope than was originally supposed, centering about the desirability of university patents on products relating to public health and medicine. There are two schools of thought on this matter: one group holding that any discovery or invention of benefit to the public should immediately be made available at the lowest price possible and with no re-

strictions. The other group supports the theory that certain products or activities of general value should nevertheless be strictly controlled to prevent their abuse and exploitation by ignorant or unscrupulous promoters.

In view of these and many other considerations the committee makes no recommendation in regard to the Wisconsin Alumni Research Foundation other than to urge a reduction of price on their products. J.A.T.

Food, Health and Income. A National Survey of Nutrition. *Lancet* 230, p. 679, March 21, 1936. A Nutritional Survey. *Brit. Med. J.*, p. 587, March 21, 1936.

These special articles review Sir John Orr's noteworthy study for the Rowett Research Institute and the Market Supply Committee, which has been published under the title, "Food, Health and Income. Report on a survey of Adequacy of Diet in Relation to Income."

Taking as a basis the optimum dietary standards described by Stiebeling of the U. S. Bureau of Home Economics, average diets of 1152 British families were analyzed, by dividing them into six groups according to income level. Weekly food expenditures ranged from 2 shillings per person up to 15 shillings or more.

With the exception of bread and potatoes, the consumption of essential foods, such as milk, eggs, fruit, vegetables, meat, and fish, rose as income increased. Thus, in the poorest group the average consumption of milk is equivalent to only 1.8 pints per person per week, while in the wealthiest group it is 5.5 pints.

The conclusions from this study raise important economic and political problems. To insure adequate diets to the poorer groups would involve increased consumption of milk, eggs, butter, fruits, vegetables and meat, varying from 12 to 25 per cent, and a necessarily greater food budget would be required. The newer knowledge of nutrition, indicating how there can be enormous improvement in the health and physique of the nation, has created an entirely new situation demanding "economic statesmanship."

J.A.T.

Further Observations of the Antirachitic Effect of Irradiated Fresh Milk.

T. G. H. DRAKE, F. F. TISDALL AND A. BROWN. *Canad. Med. Assn. J.* 34, p. 279, March, 1936.

A group of 102 infants who were under six months of age in October and November were given from ten to forty ounces daily of irradiated vitamin D milk, containing 94 international units per 20 ounces.

Clinical and x-ray studies were made over a five month period, to determine the degree of rickets, if any, in these infants. They were compared with a group of 52 infants who received ordinary pasteurized milk. All infants lived at home but their diets and general care were supervised by a competent visiting nurse.

Of the 102 infants receiving irradiated pasteurized milk at the beginning of the experimental period, 14 showed very slight rickets, 12 mild rickets and the rest no evidence of rickets. At the end of the period, in April or May, in the irradiated milk group 11 showed cured rickets and 11 healing rickets, while of the non-irradiated milk group, 17 showed active rickets and seven healing rickets. J.A.B.

Further Observations on the Comparative Antirachitic Value of Crystalline Vitamin D Administered in Milk, Corn Oil or in Propylene Glycol. J. M. LEWIS. *J. Pediatrics* 8, p. 308, March, 1936.

It has been shown in previous studies that when milk is used as a carrier for vitamin D, a lower unitage will bring about more satisfactory healing of rickets than when the vitamin D is given in some other medium, such as corn oil.

In this paper the prophylactic value of 145–290, and 1450 U.S.P. units of crystalline vitamin D given in each of three mediums is reported. The three mediums were milk, corn oil and propylene glycol. The total number of infants studied was 355.

At the end of the study the two groups receiving vitamin D in milk showed a lower incidence of rickets than did any of the other groups. No infant in the milk groups developed moderate or marked rickets, while four infants in the other groups showed evidence of more advanced rickets.

The author discusses possible reasons why milk appears to be a superior carrier for vitamin D, and advances two suggestions: one, that the combination of the calcium and phosphorus of the milk with the vitamin D may be advantageous; and two, that when milk is used as a carrier the infant gets vitamin D in small amounts with every feeding, whereas when corn oil or propylene glycol is used as a carrier, the vitamin D is given in a single dose only once a day. This theory is being investigated further. J.A.T.

The Component Fatty Acids of Goat Milk. R. W. RIEMENSCHNEIDER AND N. R. ELLIS. *Bur. of Animal Ind., U. S. Dept. of Agr., Washington, D. C.* *J. Biol. Chem.* 113, 1, p. 219, Feb., 1936.

A study was made of the nature and composition of a composite sample of 3.5 kilos of filtered butterfat prepared from the milk from a goat herd maintained on a regulated dietary régime. The butterfat was converted to methyl esters, and fractionated into 63 fractions for examination and determination of the component fatty acids.

In addition to the saturated acids of an even number of C atoms from butyric to stearic, and the unsaturated oleic acid, the presence of a number of other fatty acids was established. These included the unsaturated acids decenoic, tetradecenoic, hexadecenoic, and probably arachidonic, and the higher molecular weight saturated acids lignoceric and cerotic. Traces of

an octobromide of an unknown acid were found, probably of a C_{22} acid or an impure isomer of arachidonic acid. Estimations on the content of the component fatty acids present show general agreement with previously published analysis of the composition of goat fat, except for the absence of linoleic acid, and the presence of small percentages of decenoic acids noted above.

K.G.W.

Investigations on the Vitamin B_2 Complex. II. The Distribution of Lactoflavin and of the "Pellagra-Preventing Factor" Vitamin B_6 in Natural Products of Animal Origin. PAUL GYÖRGY, Physiological and Nutritional Laboratories, Cambridge. *Biochem. J.* 29, p. 760, 1935.

The author in this paper has determined the relative amounts of the two substances in a number of products. Concerning milk, the observation is reported that cow's milk (summer) contains about the same amount of lactoflavin as of vitamin B_6 .

K.G.W.

Investigations on the Vitamin B_2 Complex. III. The Inactivation of Lactoflavin and Vitamin B_6 by Visible Light. PAUL GYÖRGY, Physiological and Nutritional Laboratories, Cambridge. *Biochem. J.* 29, p. 767, 1935.

Both lactoflavin and the pellagra-preventing substance (vitamin B_6) obtained from a concentrate from cow's liver, may be destroyed by the visible light obtained from a 500 k.w. electric bulb.

K.G.W.

A Discrepancy Between Biological Assays and other Methods of Determining Vitamin A. RONALD S. MORGAN, Lever Bros. Ltd., Port Sunlight, England, and Joseph R. Edisbury and Richard A. Morton, Univ. of Liverpool. *Biochem. J.* 29, p. 1645, 1935.

A comparison is made of biological assays for vitamin A, Lovibond Blue values, and spectroscopic estimates of the percentage of vitamin A present for a series of 22 oils and concentrates covering a range of potency of 530 to 1,290,000 I.U. per gram. Extensive statistical analysis has been made of the data to ascertain the variation in results by the different methods.

K.G.W.

The Comparative Antirachitic Efficiency of Vitamin D in Irradiated Milk, Metabolized (yeast) Milk and Cod Liver Oil. R. M. BETHEKE, W. E. KRAUSS, P. R. RECORD AND O. H. M. WILDER. Ohio Agr. Exp. Sta., Wooster, Ohio. *J. Nutrition* 11, p. 21, Jan., 1936.

It required more than ten times the rat equivalent amount of vitamin D in metabolized (yeast) milk than in irradiated milk to produce the same antirachitic effect in chicks.

Equivalent rat units of vitamin D from cod liver oil and irradiated milk were equally efficient, antirachitically, for the chicken.

The data indicate that the vitamin D in milk resulting from feeding irradiated yeast to the cow (metabolized milk) is in the same biological form as that fed to the animal.

Since rat equivalent amounts of vitamin D in metabolized (yeast) milk and irradiated milk were found equally efficacious for the rachitic infant and not for the chick, it is concluded that the infant and chick vary greatly in their response to the forms of vitamin D in these two types of milk.

L.A.M.

The Relation of Sodium to Chlorine in the Milk of Shorthorn and Guernsey Cows. TUDOR S. G. JONES AND WILLIAM L. DAVIES, National Institute for Research in Dairying, Shinfield. *Biochem. J.* 29, p. 978, 1935.

The milk of each of twenty cows of the shorthorn and Guernsey breeds was examined to correlate the sodium and chloride contents of their milk and their period of lactation. The values for sodium and chloride ranged from 39.2 and 139.2 and 70 to 193 mg. per 100 ml. respectively, with mean values of 76.8 and 113.4 mg. per 100 ml. respectively. The relation between chloride and sodium in milk of the two breeds examined is given by the equation $Cl - 1.24 Na + 18.09$, wherein Cl and Na are expressed in mg. per 100 ml. Inasmuch as the chloride content of milk is known to increase with advance in the period of lactation, an increase in the sodium content is to be expected. The limited number of examinations did not permit statistical correlation of the Na values with advance in lactation.

K.G.W.

The Effect of Halogen Salts on the Clotting of Milk by Trypsin. WINIFRED M. CLIFFORD, Physiology Dept., King's College of Household and Social Science, Campden Hill Road, W.8. *Biochem. J.* 29, p. 1059, 1935.

When trypsin is added to milk (1 ml. of 2 per cent pancreas substance to 10 ml. of milk and 2 ml. of water) the appearance of the mixture usually remains unaltered. The addition of Ca salts to the mixture is known to affect the action to the extent that a typical firm coagulum can be obtained. An investigation of the influence of halogens (F, Cl, Br, I) in the form of salts of Li, Na, K, NH_4 , Ca, Mg and Ba indicate that the acceleration of tryptic activity in clotting of milk when $CaCl_2$ is added is as much a function of the halogen as of the Ca radical. The halogen salts of the alkaline earths were found more effective in aiding coagulation than those of Li, Na, K and NH_4 ; the coagulating action was least with fluorides. The efficacy of the alkaline earths follows the order $Ca > Ba > Mg$.

K.G.W.

Relative Value of Raw and Heated Milk in Nutrition. E. C. V. MATTICK AND J. GOLDING, National Inst. for Res. in Dairying, Reading, Eng. *Lancet* 230, p. 1132, May 16, 1936.

The authors report on a continuation of feeding experiments with rats begun several years ago and first described in 1931 (*Lancet*, March 21, 1931). Rats from the same litters were placed at weaning on diets of biscuit made from flour and water, plus (a) raw milk, or (b) "freshly" sterilized milk, or (c) "kept" sterilized milk. The "freshly" and "kept" sterilized milks are not defined in this article, but in the 1931 paper, the freshly sterilized milk was stated to be raw milk which had been heated to 210-212° F. for half an hour and fed the same day, whereas the "kept" sterilized milk had been heated in the same manner, but was fed 24 hours later.

Rats of the raw milk group were weaned on the first matings through the seventh generation, but no second generation was weaned on the "kept" sterilized milk, and no third generation on the freshly sterilized milk. After the third generation of the raw milk group, no significant differences in weight were found, and there were no dental lesions in the seventh generation animals.

The practical significance, if any, of this limited experiment is not stated. J.A.T.

The Metabolism of Galactose. II. The Synthesis of Lactose by Slices of Active Mammary Gland *in Vitro*. GORDON ALLISON GRANT, Dept. of Biochem., Lister Inst., London. *Biochem. J.* 29, p. 1905, 1935.

One of the interesting transformations in carbohydrate metabolism is that occurring in the active mammary gland during the synthesis of the galactose-containing disaccharide, lactose. While many studies have been made concerning the nature of the transformation, as well as the source from which lactose is derived, the available physiological evidence suggests that the freely lactating gland is apparently capable of withdrawing glucose from the blood, and converting it into the milk sugar, lactose. In this investigation lactose synthesis has been demonstrated and quantitatively investigated with tissue slices of the active mammary gland maintained *in vitro* under conditions as nearly as possible physiological, using as substrates the hexoses, glucose, fructose, mannose and galactose. Of the hexoses used, glucose is readily converted into lactose, while there is but little evidence of synthesis from fructose, mannose and galactose. K.G.W.

Lactoflavin, a Possible Contaminant of Vitamin-Free Diets. G. C. SUPPLEE, G. E. FLANIGAN, ZAIDA M. HANFORD, AND S. ANSBACHER, Dry Milk Co., Bainbridge, N. Y. *J. Biol. Chem.* 113, p. 787, 1936.

Casein is the basic protein in many rations used in determination of

vitamins associated with biological materials and foodstuffs. While essentially it is desired that the casein be purified and free of associated factors, it is possible that certain factors with growth promoting properties may be present. Lactoflavin has recently been shown to possess such properties, and has been found associated with certain types of casein.

The investigators showed that lactoflavin as identified by its characteristics of fluorescence in "black light," is a contaminant of crude or commercial caseins, and even certain "purified vitamin free caseins." The presence of lactoflavin in commercial caseins after extraction for extended periods with acetic acid and alcohol may be readily revealed by examination of the fluorescence in "black light." If the casein is prepared by a process involving a six step elution treatment with weak sodium chloride solution at the isoelectric point of the casein, a product entirely free of lactoflavin is obtained. The variation in the growth promoting properties of various caseins used in rations fed white rats in the experiments reported was attributed to the relative contents of lactoflavin.

The Influence of Storage, Pasteurization, and Contamination with Metals on the Stability of Vitamin C in Milk. C. H. WHITNAH, W. H. RIDDELL, AND W. J. CAULFIELD, Kan. Agr. Exp. Station, Manhattan. *JOURNAL OF DAIRY SCIENCE* 19, 6, p. 373, June, 1936.

As a result of the studies on the stability of vitamin C in milk, the authors conclude that either raw or high temperature pasteurized milk if reasonably fresh and uncontaminated with copper may be an important source of vitamin C in human nutrition. A.C.D.

Effects of Time and Temperature of Holding Milk Heat-Treated at Various Temperatures Upon its Subsequent Coagulation by Rennet. MILTON E. POWELL, Div. of Agr. Biochem., Univ. of Minn., St. Paul. *JOURNAL OF DAIRY SCIENCE* 19, 5, p. 305, May, 1936.

This study dealt primarily with the slight change which occurs in the rennet coagulation of pasteurized milk during aging subsequent to pasteurization. A.C.D.

The Effect of the Adsorption "Membrane" Around the Fat Globules on the Curd Tension of Cow's Milk. L. S. PALMER AND N. P. TARASUK, Div. of Agr. Biochem., Univ. of Minn., St. Paul. *JOURNAL OF DAIRY SCIENCE* 19, 5, p. 323, May, 1936.

The authors conclude that the "membrane" adsorbed on the fat globules in milk has a definite effect in lowering curd tension. A.C.D.

Normal Variations in the Curd Tension of Milk. W. H. RIDDELL, W. J. CAULFIELD AND C. H. WHITNAH, Kan. Agr. Exp. Sta., Manhattan. *JOURNAL OF DAIRY SCIENCE* 19, 3, p. 157, March, 1936.

The breed of cows, the individuality of the cow, and the stage of the

lactation period were of major importance in determining the curd tension of the milk. A.C.D.

The Fluorometric Estimation of Lactoflavin. G. C. SUPPLEE, S. ANSBACHER, G. E. FLANIGAN, AND Z. M. HANFORD, Res. Lab. of the Dry Milk Co., Inc., Bainbridge, N. Y. JOURNAL OF DAIRY SCIENCE 19, 3, p. 215, March, 1936.

A method was presented for estimating lactoflavin in milk by its fluorescent properties in "black light." A.C.D.

Soybean Flour as a Substitute for Cow's Milk in Feeding Dairy Calves. LAVAN SHOPTAW, Panhandle Agr. Exp. Sta., Goodwell, Oklahoma. JOURNAL OF DAIRY SCIENCE 19, 2, p. 95, February, 1936.

Contrary to some statements in the literature the author failed to secure as good results with soybean flour as was secured from cow's milk in raising dairy calves. A.C.D.

Is Bovine Mastitis a Public Health Problem? PAUL B. BROOKS, N. Y. St. J. Med. p. 584, April 1, 1936

The control of bovine mastitis is more of an economic than it is a public health problem, in the opinion of the author. Many milk-borne epidemics are traceable to cows with mastitis, but "the cases of mastitis known to be dangerous to human health are those in which the infecting organisms are transmitted to the cows' udders from infected persons," such as milkers. Eradication of mastitis would not prevent such infections, and milk-borne epidemics could occur before even a careful dairyman could recognize the condition as present in his herd. "Pasteurization, therefore, is the only dependable safeguard" to prevent such outbreaks. J.A.T.

Formaldehyde as a Selective Bacteriostatic Agent. W. J. WILSON. J. Path. Bact. 40, p. 199, 1935.

In an attempt to find a selective medium for the isolation, cultivation and differentiation of *B. coli* and *B. lactis aerogenes*, 2 cc. of a 40 per cent solution of hexamine was added to lactose peptone water. It was believed that the bacteriostatic action of the hexamine was due to the liberation of formaldehyde since formaldehyde had a similar action. With heavy implantations the strength of formaldehyde used was 1:20,000 and 1:50,000, whereas with light implantations, as in water, one-half these concentrations were used. Readings were taken at the end of 24 hours. Experiments showed that in lactose-peptone-water medium containing 5 cc. of a 1:40 watery solution of hydroquinone and 5 cc. of 1:1000 formalin the growth of fecal *B. coli* was profuse and that of *B. lactis aerogenes* suppressed. The reagents were added just before the medium was used. The author hopes

to be able to use this method in determining fecal *B. coli* contamination in milk, water, foods, etc. F.W.F.

New Culture Media Based on Sodium Desoxycholate for the Isolation of Intestinal Pathogens and for the Enumeration of Colon Bacilli in Milk and Water. EINAR LEIFSON, J. Path. Bact. 40, p. 581, 1935.

The source and general chemical nature of desoxycholic acid and its salts are discussed. This acid and its salts are compared with some of the other acids found in bile. The effect of desoxycholic acid on bacteria together with the effective pH ranges for different bacteria are given. These data are represented graphically in the form of a chart. The effect of various substances such as the salts of the straight-chain fatty acids, the higher aliphatic acids, dyes, iron salts, and raw milk on desoxycholate infusion agar are discussed.

Directions are given for making up desoxycholate agar and the influence of the different ingredients upon the medium. The medium best suited for enumerating the colon bacilli in milk and milk products is discussed in detail. According to the author, colon bacilli grow rapidly in the desoxycholate agar and appear as large, red colonies in 15 to 20 hours, whereas other colonies are barely visible in this time. *Proteus* colonies are slightly pinkish and are surrounded by a clear area due to the hydrolysis of the casein in the milk. The *Proteus* colonies are so characteristic that this medium may also be used to count them in the milk. By decreasing the concentration of lactose, the deep colonies of *Aerobacter* generally become quite colorless in 24 hours. Some difficulty may be experienced in differentiating between the surface growth of the colon bacilli and other bacteria.

The author describes many other uses which may be made of the desoxycholate agar when combined with sodium and ferric ammonium citrates and also when P₆ peptone is used. Fecal streptococci and enterococci and many other types of streptococci may also be isolated by changing the pH. Flagellated bacilli become non-flagellated as long as they are kept in contact with desoxycholate but regain their flagella when transferred to other media.

F.W.F.

Evaluation of Certain Media for the Detection of Colon Organisms in

Milk. C. N. STARK AND L. R. CURTIS, Lab. of Bact., Cornell Univ., Ithaca, N. Y. Am. J. Pub. Health 26, 4, p. 354, April, 1936.

The authors found that crystal violet, Dominick-Lauter and gentian violet broths were not satisfactory for use in the detection of colon organisms in 1 cc. quantities of milk, due to growth of a considerable number of false test organisms. Brilliant green bile broth had a better selective action which was partially destroyed by the protein material in 1 cc. amounts of milk used as inoculum.

Formate ricinoleate broth can be successfully used for the detection of colon organisms in milk because: (1) it inhibits the growth of false test-organisms; (2) it permits growth and gas production by small numbers of *Escherichia-Aerobacter* organisms; (3) it results in increased bacterial growth and gas production by maintaining a favorable environment for growth; and (4) it is little affected by the additional protein material which must be added when inoculating media with 1 cc. amounts of milk. Of the bacteria tested which were able to grow in formate ricinoleate broth, only the *Escherichia-Aerobacter* and *Salmonella* groups were able to produce gas from sodium formate. The authors believe that ability of the *Salmonella* group to produce gas from sodium formate is an advantage rather than a disadvantage, since the presence of these bacteria in milk should not be tolerated.

M.W.Y.

Optimum Temperature of Incubation for Standard Methods of Milk Analysis as Influenced by the Medium. M. W. YALE, AND CARL S. PEDERSON. N. Y. Agr. Exp. Sta., Geneva, N. Y. Am. J. Pub. Health 26, 4, p. 344, April, 1936.

The authors have previously recommended an incubation temperature of 32° C. for 48 hours rather than 37° C. for standard beef-extract agar plates prepared from samples of dairy products since they found 32° C. to be a fairer and truer measure of quality than 37° C. incubation.

The possibility that the present standard agar may be replaced by a medium better suited for the growth of bacteria found in milk led the authors to study the optimum 48-hour incubation temperature for the tryptone-glucose-skimmilk agar proposed by Bowers and Hucker.

The optimum temperature in the case of raw milk was slightly below 30° C. and in the case of pasteurized milk slightly above 31° C. The conclusion is drawn that an incubation temperature of 32° C. or slightly lower is fully as desirable with tryptone agar as with the present standard agar because, (1) it yields at least 95 per cent on the average of the maximum 2-day count in comparison to only about 50 per cent in the case of 37° C. incubation, (2) less errors are caused by temperature variations in 32° C. than in 37° C. incubators; and (3) the percentage of the maximum 48-hour count does not vary greatly between samples in the case of 32° C. incubation whereas it varies greatly in the case of 37° C. incubation.

M.W.Y.

Further Studies of the Composition of Media for the Bacteriological Analysis of Milk. C. S. BOWERS, Conn. State Dept. Health Lab., Hartford, Conn., and G. J. HUCKER, N. Y. Agr. Exp. Sta., Geneva, N. Y. Am. J. Pub. Health 26, 4, p. 350, April, 1936.

Earlier work by these authors (Tech. Bul. 228, N. Y. Exp. Sta.) suggested that an agar containing tryptone (a commercial form of digested

casein), glucose and skimmilk should be substituted for the peptone-beef extract agar now accepted as the standard agar for milk work, since on the average, this medium increased the count above that on standard agar by 33 per cent when raw milk samples were studied and 147 per cent when pasteurized milk was used. The data obtained in the present study substantiates the above conclusion.

Increases in count were irregular due to the fact that samples contained different proportions of the types of bacteria which grew poorly or not at all on standard beef extract agar.

The addition of either skimmilk or glucose to standard agar materially increased its efficiency although such a modification did not result in standard agar becoming as efficient a plating medium as tryptone-glucose agar or tryptone-glucose skimmilk agar. Tryptone-glucose agar was not quite as efficient as the same agar to which skimmilk was added. Tryptone was approximately 37 per cent more efficient than neopeptone (a second commercial form of digested casein) from the standpoint of number of colonies developing on plates made from pasteurized milk. M.W.Y.

The Detection of Mastitis in Dairy Herds. D. H. JACOBSEN, AND T. M. OLSON, Bul. 290, 1935, So. Dak. State College, Brookings.

The economic aspects, causes and control of mastitis are discussed. The college herd consisting of 54 cows was checked for a period of 16 months. Of the 54 cows, 14 produced milk which gave positive tests and was physically abnormal, containing clots or sediment or was serous or thick in consistency. Twenty-seven were positive to the Brom thymol blue and catalase tests and had high leucocyte counts. Twenty-four of the 27 showed either long-chain streptococci or staphylococci in the milk at some time during the trials. Thirteen cows which were termed suspicious to positive but never showed milk of abnormal consistency during the experiment gave positive laboratory tests as follows: Of 450 "quarter" samples tested 174 or 32.2 per cent were positive to the Brom thymol blue test. One hundred ninety-two or 35.6 per cent showed more than 500,000 leucocytes per cc. Two hundred fifty-two or 46.7 per cent produced more than 1.5 cc. gas by the catalase test. Eighty-eight or 16.3 per cent showed long chain streptococci incubated samples.

Conclusions:

1. Laboratory tests were a valuable aid in detecting cases of chronic mastitis which would have passed unnoticed by the milkers.
2. Because of the mild and recurrent nature of the infection the tests must be used at frequent intervals to detect and eliminate dangerous sources of infection.
3. Infection is frequently confined to one or more quarters of an udder. Therefore the detection of milk from such quarters is necessary in controlling the spread of infection.

4. Brom thymol blue tests, catalase test, and cell counts all seem to be satisfactory tests for the detection of mastitis. The Brom thymol blue test is the simplest in operation and is recommended for dairy herd control.

5. Microscopic examination of stained smears is not a good routine method of detecting "mastitis" milk when used alone because a relatively low percentage of the samples from abnormal udders contain long-chain streptococci.

6. Positive Brom thymol blue, catalase and high cell count do not definitely prove mastitis infection but the tests are an indication of abnormal milk which is at least presumptive evidence of an abnormal udder condition.
C.C.T.

Testing of Abortus Vaccines and their Protective Action against the Disease in Cattle. H. ZELLER AND W. STOCKMAYER, *Infektion. Parasitäre Krankheiten Hygiene Haustiere* 48, 1/2, p. 77, 1936.

Several vaccines were studied but these investigators were not able to establish the value of them during the first pregnancy period. They were perhaps of slight value in reducing sterility during the second period. There also appeared to be little difference between the number of abortus bacilli in the organs of treated and control animals after slaughter. At the close of the second year of the experiment 32 cows and one bull were slaughtered. Of the cows, 30 gave positive reactions by the agglutination test and only 19 were positive by the complement-fixation test. The three animals negative to all tests were proved not to be carriers of the abortion bacillus on post-mortem examination. About half of the 40 animals studied did not yield positive cultures from their internal organs. Of the 22 which were positive, 18 were found to be infected in the udder and 15 in the udder-lymphatics. Five yielded the abortion bacillus from the intestinal-lymphatics. Three of these animals had given normal births. This is thought to indicate that the abortion bacillus may disappear from the uterus but not from the udder. The organisms were not found in the liver or bone marrow in any of the infected animals. They were found once in the spleen, and mesenteric lymphnodes, in the retropharyngeal lymph nodes in 2 animals.

From the fact that these organisms establish themselves in the udder and are able to persist for such long periods, and are of importance from a public health standpoint, the writers are opposed to the use of live-germ vaccines of an attenuated type for the vaccination of cows. The control of the disease must depend on the application of serological tests and hygienic measures for its control.
L.D.B.

Investigation of the Use of Entozon in Mastitis. *Infektion. Parasitäre Krankheiten Hygiene Haustiere* 48, 1/2, p. 95, 1936.

These tests were conducted on several herds of dairy cows which were found to be infected in the udder by streptococci. The usual methods were

used to diagnose the condition. When a diagnosis was certain the quarter was freed of milk and injected with about 100 cc. of a 1 to 1250 warmed solution of Entozon. This fluid is then removed and again treated in the same manner. Care is observed not to inject too much fluid. This is followed by slight massage. The infusion remains in a dry animal for 20 to 24 hours, in lactating animals 3 to 5 minutes. The use of this method has proved to be quite favorable as a curative agent in quarters where there is a minimum of pathological change. Many animals are treated 3 to 5 times per week in this manner.

The author emphasizes the value of sanitation and quarantine in the control of this disease. He advocates giving careful instructions to the owners and milkers of infected herds. L.D.B.

Some Effects of the Proposed New Bacteriological Techniques. JOSEPH F. PHILAN, Lab. of H. P. Hood and Sons, Inc., Boston, Mass. JOURNAL OF DAIRY SCIENCE 19, 6, p. 385, June, 1936.

Incubation of tryptone glucose skim milk agar at 32° C. produces higher bacterial counts and Standard Methods of Milk Analyses should not be altered to affect the bacterial count without careful consideration to present bacteriological standards. A.C.D.

Detecting Recontamination of Pasteurized Milk by Bacteriological Methods. W. H. CHILSON, M. W. YALE, AND R. EGLINTON, N. Y. State Agr. Exp. Sta., Geneva, N. Y. JOURNAL OF DAIRY SCIENCE 19, 5, p. 337, May, 1936.

Since properly pasteurized milk free from recontamination contains less than 1 colon organism per cc. it is evident that the test for the colon bacteria may be used to supplement the results secured by the standard agar plate count in determining recontamination of pasteurized milk. A.C.D.

Rennet Test for the Detection of Mastitis. F. B. HADLEY, Dept. of Vet. Science, Univ. of Wis., Madison. JOURNAL OF DAIRY SCIENCE 19, 3, p. 165, March, 1936.

The author concludes that the time required for milk to coagulate with rennet is a valuable test to aid in detecting mastitis. A.C.D.

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ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

BUTTER

A Simplified, Improved Method for the Preparation of Cream for Churning. ASSEN KANTARDJIEFF, Univ. of Sofia, Bulgaria. *Milchw. Forsch.* 17, 5, p. 206, Dec., 1935.

Rich cream is pasteurized and cooled to 5–8° C. A quantity of skim-milk equal to 50–65 per cent of the weight of the cream is heated to 90° C., cooled to 43° C., inoculated with *Lactobacillus bulgaricus*, alone or with *Streptococcus thermophilus*, held at 43° C. until the acidity reaches 1.58–1.80 per cent. The starter is then cooled to such a degree that, when it is mixed with the cream, the mixture is about 1° C. below the churning temperature and the acidity about .675–.765 per cent. The cream is then churned and the butter worked as usual. The process seems to be especially useful for sheep or buffalo cream. The buttermilk has the healthful properties of Yogurt. Complete directions and data are given. H.M.

Aroma Production of Fermented Milk. O. K. PALLADINA, W. A. MAZJUKEWITSCH, E. L. MILOWA AND N. S. GRIGORJEW. Central Fat Inst., Leningrad, U. S. S. R, *Milchw. Forsch.* 17, 5, p. 222, Dec., 1935.

The flora and general characteristics of several fermented milk beverages and starters are described. Observations were made on the biochemical changes produced in milk by individual strains or combinations of *Streptococcus lactis*, *S. cremoris*, *Leuconostoc Mesenteroides*, *S. citrovorus*, *S. paracitrovorus*, *Lactobacillus acidophilus*, *L. bulgaricus*, *L. casei*, *Streptocasterium* and *Betabacterium*. Data are presented on the relation between pH and total acidity, the effects of temperature of incubation, various combinations of strains, symbiosis, addition of citric acid and synthetic diacetyl and the action of diacetyl produced by cultures. Starters of selected strains of *S. cremoris* were found desirable for margarine, with an active strain of *S. lactis* for a more marked flavor. To improve flavor and to avoid high acidity, aroma-producing cultures were introduced especially for storage goods. The formation of diacetyl did not always mean a good flavor in the starter but a good active culture of aroma cocci produced a high volatile acidity as well as diacetyl, while the best starters always developed diacetyl. Lactobacilli producing diacetyl and high acidity were not satisfactory although betacocci were good. Synthetic diacetyl was held in fermented milk only in the presence of the aroma strains plus *S. cremoris* while *S. lactis* brought about its decomposition. H.M.

CHEESE

Determination of Metals in Milk Products. I. Determination of Copper in Cottage Cheese. G. SCHWARZ, O. FISCHER AND H. STOTZ. Chem. Inst., Prussian Exp. and Research Inst., Kiel, Germany. *Milchw. Forsch.* 17, 6, p. 314, April, 1936.

A method for determining copper in cottage cheese (quarg) is outlined in detail and extensive data are reported. The quarg is first treated with concentrated H_2SO_4 and HNO_3 in Kjeldahl flasks to destroy the organic matter. The copper is detected by means of "dithizon" (diphenylthiocarbazone) which produces an intensely colored compound in the presence of copper. The depth of color is measured by a photometer. Considerable amounts of trivalent iron in the quarg reduce the accuracy of this method but this disturbing influence may be eliminated by a treatment of the fluid with hydrazine sulphate which converts the iron into the ferrous state. Further contributions are promised to give methods for determining Cu and Zn in other dairy products. H.M.

Behavior of Different Groups of Lactic Acid Bacteria in Emmental Cheese. I. Quantitative Investigations. KARL J. DEMETER AND SCHMID. Bact. South German Research Inst. for Dairying in Weihenstephan, Tech. College, Munich, Germany. *Milchw. Forsch.* 17, 5, p. 244, Dec., 1935.

The milk used for the manufacture of Emmental cheese in Allgäu, showed rather uniformly high counts of lactic acid bacteria. In the early stages of curdling, the number of streptococci increased more than the lactobacilli. In the course of scalding and immediately thereafter, a significant decrease in streptococci occurred, while the long rods remained constant. The selective action of heat, subsequently and during the pressing, resulted in an increase of the thermophilic streptococci and lactobacilli whereby the latter became much more prominent. In further course of ripening, the rods decreased quite uniformly until the end of the ripening while the streptococci after three weeks in the fermentation cellar reached a lower stage than previously, but finally increased considerably again up to the end of ripening in the storage cellar. The originally-dominant *S. lactus* types completely receded from the time of exposure to the salt bath. At the same time, *S. thermophilus* reached its high point in order to clear the field in turn for the betacocci and other thermophilic streptococci in the course of further ripening. A special relation between the appearance of betacocci and green feed could also be found (May cheese). Within the Lactobacillus group, the streptobacteria appeared from the third week in the fermentation cellar and their numbers further increased until the seventh week only to decrease again after that time.

So the streptobacteria appeared to play an important role in the ripening at that time. In cheese that was defective, there was a deviation from the normal course of streptococci and streptobacteria. The bacterial flora of rennet also merits consideration. H.M.

Behavior of Individual Groups of Lactic Acid Bacteria in Emmental Cheese. II. Systematization of Lactic Acid Bacteria Found.

KARL J. DEMETER AND HERMAN SCHMIDT. Bact. Inst. South German Research Inst. for Dairying, Weihenstephan, Tech. College, Munich, Germany. *Milchw. Forsch.* 17, 5, p. 270, Dec., 1935.

The bacteria isolated from 10 Emmental cheese at various stages in the manufacturing and curing processes are described according to the system suggested by Orla-Jensen. The importance of *S. thermophilus*, first pointed out in the United States, was confirmed. Another Streptococcus, not identical with *S. thermophilus* was probably closely related to *S. faecium* Orla-Jensen was found. It was present throughout the manufacturing process and perhaps is related to the ripening streptococci mentioned by Hanusch. A betacoccus was found in good and bad cheese in approximately the same numbers as well as *Tetracoccus liquefaciens* and *Tetracoccus casei* which were found only in limited numbers. *Thermobacterium helveticum*, which disappears toward the end of ripening, *Thermobacterium lactis*, which takes the place of the former, *Streptobacterium casei*, which predominates in normal cheese after 3 to 6 weeks ripening in the cellar, and *Streptobacterium plantarum*, which, until now, has not been observed in Emmental but found in astonishing numbers only in very unsuccessful cheese at the time of green or beet feeding, are also described. Acidoproteolytes (Forini) were found so rarely that their importance in the normal ripening of Emmental is again questioned. Further investigations are necessary to determine the role of each type in the ripening process. H.M.

Contributions to the Chemistry of Cheese Ripening. III. Knowledge of Caseoglutin. W. GRIMMER AND WALTER LENGE, Univ. of Konigsberg, Germany. *Milchw. Forsch.* 17, 6, p. 352, April, 1936.

Caseoglutin obtained from ripened Tilsiter Cheese was shown to be made up of three fractions characterized as follows: (a) caseoglutin alpha, insoluble in 40 per cent acetone, (b) caseoglutin beta, soluble in acetone, isoelectric point, pH 5.3, amounts to 15.5 per cent of original caseoglutin and (c) caseoglutin gamma, soluble in acetone, isoelectric point, pH 7.0, amounts to 12.8 per cent of original caseoglutin. The fractions show a lower sulphur content than the raw product. The phosphorus content does not appear to be bound organically but rather mixed with CaHPO_4 . The amino acids present in the alpha fraction were determined. The high leucine (15.13 per cent) and proline (7.1 per cent) content are striking

while valine, glutamic acid and the hexase bases are markedly lower than casein or the caseoglutin described by Grimmer and Schultzer. Extensive data are reported. H.M.

ICE CREAM

Distribution of Butterfat in Frozen Cream. H. C. TRELOGAN AND W. B. COMBS, Univ. of Minn., St. Paul. *Milk Dealer* 25, 9, p. 44, June, 1936.

Results of this work indicate that cream does not freeze homogeneously under any of the conditions outlined. There is a reduction in the fat content around the sides and bottom of the frozen cream. Nevertheless, the fat distribution in cream frozen in cold storage is more uniform than in frozen milk, and the uniformity is relatively greater as the butterfat content of the cream increases. The migration of the butterfat in frozen cream can be explained in part by fat-rising for the lower-rising creams, but a more adequate explanation may be found in the manner in which the cream crystallizes.

Freezing of cream in cold storage is initiated when the aqueous part along the sides and bottom begins to solidify. As the ice crystals expand, they tend to push the fat globules toward the center. This accounts for the slightly reduced fat content along the sides and bottom. But the movement is checked as freezing progresses, because the ice bands growing in varied directions meet and form cavities in which fractions of the fat are trapped and are subsequently packed together with further growth of the ice crystals. The top of the cream is the last boundary to begin freezing, because of the air insulation in the can. When the top becomes totally frozen and rigid, pressure is gradually accumulated inside the cream with further freezing until a point is reached when the pressure causes the top to bulge. This inside pressure probably tends to inhibit further movement of the fat in the viscous fluid that is freezing and thus eliminates any concentration of the fat in the center of the freezing mass. As the freezing progresses, successively smaller portions of the fat are enveloped by the growing ice sheets until the center is solidified and the cream is totally frozen. C.J.B.

A New Time Saving Chart. THOMAS D. CUTLER, *Ice Cream Trade J.* 32, 9, p. 22, Sept., 1936.

A computing chart is presented and directions given for its use in standardization. Dairy plant problems, such as the standardization of milk and cream, and the proportioning of ice cream mix ingredients, may be quickly solved by means of the chart. W.H.M.

Careful Sanitation is Necessary in Manufacturing Ice Cream. J. H. FRANDSEN, Mass. State College, *Ice Cream J.* 32, 9, p. 26, Sept., 1936.

Bacteria counts, at frequent intervals, are recommended by the author. He also suggests methods for use in the washing and sterilizing of plant equipment. W.H.M.

Significance of Laboratory Tests in the Control of Ice Cream. F. J. BABEL, *Ice Cream Trade J.* 32, 9, p. 35, Sept., 1936.

As stated by the author, "The purpose of this study was to compare: (1) tryptone-glucose-skimmilk agar, standard nutrient agar plus one per cent sucrose, and standard nutrient agar for determining the total bacterial count of ice cream; (2) brilliant green lactose peptone bile, formate-ricinoleate broth, Leifson's desoxycholate agar and Bacto violet red bile agar in detecting the presence of the *Escherichia-Aerobacter* group in ice cream; and (3) to determine the number of yeasts and molds, thermoduric, thermophilic, and spore-forming organisms in ice cream and their relation to the total count.

A summary of the results follows:

1. The analysis of 192 samples of commercial ice cream for total bacteria showed tryptone-glucose-skimmilk agar to be superior to standard nutrient agar on standard nutrient agar plus one per cent sucrose. Tryptone-glucose-skimmilk agar gave higher total counts and colonies of greater size than did the other two media. Standard nutrient agar plus one per cent sucrose gave, on the average, slightly higher counts and colonies of greater size than did standard nutrient agar.

2. Violet red bile agar was superior to sodium desoxycholate agar in the detection and enumeration of members of the *Escherichia-Aerobacter* group of organisms in ice cream.

3. No significant difference was found in a comparison of formate-ricinoleate broth and brilliant green lactose peptone bile in their ability to detect the presence of the *Escherichia-Aerobacter* group of organisms in ice cream.

4. Violet red bile agar and sodium desoxycholate agar are superior to formate-ricinoleate broth or brilliant green lactose peptone bile in detecting the presence of the *Escherichia-Aerobacter* group of organisms in ice cream.

5. The most frequent ratio occurring between thermophilic, thermoduric, and spore-forming bacteria in relation to the total count was 1 to 1:10.

6. Strawberry ice cream contained the largest number of spore-forming organisms as compared with vanilla or chocolate. Chocolate ice cream had the highest ratio of spores to total bacteria, indicating few spore-forming organisms.

7. A direct relation was secured between the total bacterial count and the yeast and mold count of ice cream. The yeast and mold count usually increased with an increase in the number of total bacteria. W.H.M.

Freezing Ice Cream. P. H. TRACY, Univ. of Ill., Urbana, Ill. *Ice Cream Trade J.* 32, 7, p. 19, July, 1936.

The author reviews the literature on this subject mainly comparing the batch and continuous freezing. The factors which influence mix whipping are: percentage of butter fat, percentage of serum solids, sugar content, presence of stabilizers, salt content, amount of egg yolk used, acidity of mix, and homogenization and aging of mix.

Directions for care of brine and direct expansion freezers are given.

W.H.M.

Homogenization of the Mix. W. H. E. REID, Univ. of Mo, Columbia, Mo. *Ice Cream Trade J.* 32, 6, p. 15, June, 1936.

Homogenization is discussed from standpoint of: quality of final product, influence of temperature, application of various pressures, effect on bacteria count and care of the homogenizer.

W.H.M.

Selecting the Proper Ingredients to Make a Good Ice Cream. M. J. MACK, Mass. State College, Amherst, Mass. *Ice Cream Trade J.* 32, 3, p. 23, March, 1936.

This article deals with the selection of ingredients for a good ice cream mix from the standpoint of economy, balance of solids, and quality of the final product.

W.H.M.

The Use of Stabilizing Agents in Manufacturing Ice Cream. P. H. TRACY, Univ. of Ill., Urbana, Ill. *Ice Cream Trade J.* 32, 3, p. 31, March, 1936.

The need for some form of stabilizing agent in the manufacture of commercial ice cream is commonly recognized. Gelatin is the most ordinarily used product, as a very satisfactory stabilizing agent for ice cream.

The popularity of gelatin in ice cream has encouraged the introduction of certain substitutes of which, sodium alginate, hygell, and pectin, are discussed as to the advantages and disadvantages as compared to gelatin as stabilizers for ice cream.

W.H.M.

MILK

The Need for Better Methods of Feed Conservation in the Production of Premium Milk. JOHN HUNGERFORD, Blue Ribbon Farms, Kansas City, Mo. *Proc. of 28th Annual Con. Intern. Assoc. Milk Dealers, Production Section.* p. 42, 1935.

The author states his belief that stimulation to high production by heavy grain feeding may render dairy cattle more susceptible to mastitis. He reports that over 30 per cent of a herd under his supervision became infected

in the early spring of 1932 when being fed upon a ration of approximately 10 pounds alfalfa hay, 45 pounds silage and grain at the rate of 1 to 3. That fall they started to use feeds conserved by the A. I. V. process and decreased the grain ration to a ratio of 1 to 4 or $4\frac{1}{2}$. Since starting this program the herd has been relatively free from mastitis. The author observes that whereas during the early spring months of the two previous years they had experienced heavy calf losses from pneumonia that since going on this A. I. V. feeding program the calf losses have been negligible.

During the period of three years of using the A. I. V. method of feed preservation there has been a decided improvement in the color of the winter milk and physical analysis for carotin and bio-assays for vitamin A have shown practically double the carotin content and 50 per cent more vitamin A potency than milk from another herd fed similar feeds conserved by the usual process. There was also strong indications that there was present in the A. I. V. produced milk a nutritional property which protected the experimental animals from pneumonia to a much greater extent than ordinary winter milk. The author states that from an economic standpoint the A. I. V. process is entirely practical. E.F.G.

Factory-built Milk Houses. Milk Dealer 25, 10, p. 34, July, 1936.

A description is given of a low-cost factory-built milk house. The concrete work is the only part of the structure that is made on the farm.

C.J.B.

From Cow to Consumer. W. A. WENTWORTH, Milk Dealer 25, 10, p. 2830; 44-46, July, 1936.

The author answers charges made against milk dealers the country over. He explains why the producer is paid according to the use to which the milk is placed; how producers in the milk industry have been faring compared with beef farmers, cotton farmers, grain farmers, and the like; how our system of many private distributors compares in efficiency with a single municipally-owned distribution system in Wellington, New Zealand.

C.J.B.

Government Control and the Dairy Industry. H. P. DAVIS, Univ. of Nebr. Milk Dealer, 25, 9, p. 90, June, 1936.

The author discusses the trend of public sentiment toward thinking of the milk supply in the same way that a water supply or sewage is regarded. He concludes that it is only through greater responsibility within the industry that we can have less governmental control. C.J.B.

Speaking from Experience about Bottled, Homogenized Milk. Milk Dealer, 25, 9, p. 40, June, 1936.

The experiences of some milk dealers with homogenized milk are related. Practically all of these dealers report favorably for homogenized milk and some predict there is a big field for this product. C.J.B.

Milk Cooling and the Effect of Cooling on Flavor. LOUIS L. MONTEI, Moores and Ross, Inc., Columbus, Ohio. Proc. of 28th Annual Conv. Intern. Assoc. Milk Dealers, Production Section, p. 32, 1935.

The use of various types of cooling equipment is described. The insulated storage tank is especially emphasized. Sources of off flavors in milk are enumerated and directions given for avoiding these flavors. The author stresses the importance of good flavor if milk consumption is to be maintained and increased. E.F.G.

The Value of Milk Judging Contests to the Milk Dealer. W. H. E. REID, Univ. of Mo., Columbia, Mo. Proc. of 28th Annual Conv. Intern. Assoc. Milk Dealers, Production Section, p. 23, 1935.

The value of milk contests for producers, public health officials, plant employees, consumers and students is discussed separately for each of these groups. At a milk and cream judging contest recently sponsored by the University of Missouri, 56 teams chosen from 4,300 vocational agriculture students participated. E.F.G.

Advantages and Disadvantages from Dealer and Producer Standpoints in Receiving Milk Twice a Day. J. V. QUIGLEY, County Club Dairy Co., Kansas City, Mo. Proc. of 28th Annual Conv. Intern. Assoc. Milk Dealers, p. 8, 1935.

The author states that if all milk producing farms could be equipped with mechanical refrigeration there would be no reason to consider twice a day receiving of milk but that under the usual conditions there is no way by which milk can reach the plant in as good condition as by delivering it without cooling within two hours after milking. Twice a day delivery is a method of milk improvement which will cost the dealer more money for delivery but the author states that it is probable that those dealers who have had it forced upon them by health agencies or who have had experience with it through their voluntary adoption of it as good business practice would not, if it were possible, go back to once a day receipt of milk, particularly if their market lies in a warm area. E.F.G.

New Developments of Milk Plant Equipment During Past Year. E. N. MUZZY, Carnation Company, Seattle, Washington. Proc. of 28th Annual Conv. Intern. Assoc. Milk Dealers, Plant Section, p. 3, 1935.

Thirty or more of the leading manufacturers of equipment submitted data and information which were summarized to indicate recent trends.

Simplicity with fewer parts to wear out, easier and quicker cleaning and durability were stressed. More liberal use of stainless steels and special metals and advances in welding technique, especially butt welding, were noted. E.F.G.

Power Plant Operation. RALPH COPP, Pevely Dairy Co., St. Louis, Mo. Proc. of 28th Annual Conv. Intern. Assoc. Milk Dealers, Plant Section, p. 20, 1935.

The cost of power requirements can frequently be reduced by a careful combination of the use of high and low pressure steam, Diesel plant and the purchase of electric power. The latter two methods are frequently economies in seasons when low pressure steam is largely wasted. E.F.G.

Discussion: Homogenized Milk Symposium. R. J. QUIRIE, London Ontario, Canada. Proc. of 28th Annual Conv. Intern. Assoc. Milk Dealers, Plant Section, p. 66, 1935.

A survey questionnaire submitted by the Department of Agriculture for the Dominion of Canada and in which 40 Canadian plants participated reveal a wide diversity of plant practice in dealing with homogenized milk problems. From the results of the questionnaire the most generally accepted practices are indicated. E.F.G.

Refrigeration of Trailer Bodies. C. R. MYER, JR., Whiting Milk Companies, Boston, Mass. Proc. of 28th Annual Conv. Intern. Assoc. Milk Dealers, Plant Section, p. 93, 1935.

The advantages and disadvantages of ice, direct expansion ammonia from the plant, brine from the plant, both of the latter distributed through pipes in the sides or top of the 1200 case trailer body; Kold Hold evaporators, blower with flexible air ducts which could be connected at the plant and, lastly, a compressor mounted on the chassis are presented. The latter was considered to be the best and would cost a little more than \$600.00 per trailer, which would be saved in less than a season. E.F.G.

The Effect of Metals on Flavor of Dairy Products. H. A. TREBLER, Seal-test System Laboratories, Inc., Baltimore, Maryland. Proc. of 28th Annual Conv. Intern. Assoc. Milk Dealers, Plant Section, p. 107, 1935.

A discussion of the commercial importance of off flavors, their detection and prevention is given. The more desirable metals and alloys for dairy plant equipment are discussed. E.F.G.

Oxidized Flavor in Milk. L. M. THURSTON, West Virginia Univ., Morgantown, West Va. Proc. of 28th Annual Conv. Intern. Assoc. Milk Dealers, Laboratory Section, p. 121, 1935.

It is shown that copper or iron must be in solution in milk to produce oxidation flavor. Also that samples in which oxidized flavor can be developed by the addition of 1.3 p.p.m. of the soluble copper require about 60.0 p.p.m. of the soluble iron to cause the same intensity of flavor.

Results have shown it is possible to make milk susceptible to the development of oxidized flavor when soluble copper is added by maintaining the cows on a dry feeding régime and to make the milk nonsusceptible by a pasturing régime. Preliminary work indicates that light alone may not develop the flavor.

Both in February and March $\frac{1}{2}$ of the cows in the Experiment Station herd supplying milk for the study of mixed milk were producing milk that became oxidized spontaneously and in April the proportion was reduced to $\frac{1}{3}$ yet the mixed milk never developed oxidized flavor unless copper was added to it. This evidence indicates that it is very unlikely that oxidized flavor will develop in mixed milk of a type usually received at the milk plants unless the milk becomes contaminated with copper or iron after it is drawn from the cows.

All evidence indicates that tinning exposed copper and iron surfaces will prevent the development of oxidized flavor. Although growth of bacteria for a few hours to reduce the oxidation-reduction potential of the milk will prevent oxidized flavor it is probably not advisable and is not necessary if the milk is not contaminated with iron or copper. E.F.G.

Certain Problems Related to the Marketing of Homogenized Milk. P.

H. TRACY, Univ. of Illinois, Urbana, Illinois. Proc. of 28th Annual Conv. Intern. Assoc. Milk Dealers, Plant Section, p. 39, 1935.

During a period of three years the percentage of bottled homogenized milk sold by the University creamery increased from 10 per cent at the beginning to about 40 per cent at the end of the three years. The reasons given by the customers themselves for its use were the richer flavor, homogeneous nature, convenience and general adaptability for kitchen use.

Curd tension was usually sufficiently reduced to qualify as soft curd milk with curd tension below 30. Little advantage was obtained in reducing curd tension when homogenization pressures above 2000 were used.

The sediment frequently appearing in homogenized milk was due largely to body cells and possibly to some extent to destabilized casein. Clarification after homogenization at any temperature between 90° and 140° F. prevented the formation of the sediment. Clarification after homogenization was preferable to clarification before homogenization.

A pressure of at least 2000 lbs. at 115° F. or above was desirable to prevent creaming.

Satisfactory Babcock tests on homogenized milk were obtained when both acid and milk were at 70° F. and the acid was added in small portions

with thorough mixing after each addition. About 1.5 cc. less acid was needed than for normal milk.

A determination of the degree of color showed the homogenized milk to have less color, which was explained by the adsorption of an increased protein layer on the increased fat surface.

Frozen homogenized milk presented a normal appearance upon thawing as the usual fat churning was not in evidence.

Homogenized milk was more sensitive to sunlight and became rancid very quickly after homogenization while raw unless heated immediately to pasteurizing temperature.

To insure milk of good keeping quality the following procedure was used when cleansing the homogenizer.

1. When through using, disconnect pipe leading from machine to vat, insert hose in inverted end of pipe leading to homogenizer, turn on cold water. Operate machine with some pressure until water at discharge is clear.

2. Remove all parts from head and then return plugs to lower ports.

3. Permit hot (175° F.) water to flow through machine while in operation from three to five minutes.

4. Wash all removable parts in pail using hot water.

5. Dry machine head and all parts with compressed air.

6. A short time before using assemble machine and pump through at least 50 gallons of chlorine solution (50 parts of chlorine per million).

7. Rinse with cold water immediately.

8. Pump through hot (175° F.) water just before using. E.F.G.

Scoring Milk for Flavor. E. L. FOUTS AND J. I. KIETH, Oklahoma A. and M. College, Stillwater, Oklahoma. Proc. of 28th Annual Conv. Intern. Assoc. Milk Dealers, Laboratory Section, p. 116, 1935.

Scoring 5000 samples of milk and employing the chart devised by Fouts and Weaver only six flavor defects were found with decided frequency. These in the order of frequency were as follows:

Flavor criticism	Per cent of all observations
feed	19.7
cowy	15.5
rancid	10.4
stale	8.5
salty	4.7
flat	4.6

When the above criticisms were used alone or in combination with others they accounted for 98.6 per cent of all criticisms made.

Alfalfa hay, when fed before milking, has a marked effect upon the flavor of the milk. The defect was noticeable in 30 minutes or less after feeding, was most intense at about 2 hours and had largely disappeared after 4 hours. The flavor was more intense and persisted for a longer time in Jersey than in Holstein milk.

Cooling without aeration had little effect but cooling and aeration helped to reduce the intensity of alfalfa feed flavor but did not remove it entirely.

E.F.G.

Orange Juice and Orangeade for the Dairy Trade. H. H. MATTERN, Bureau of Chemistry and Soils, U. S. A., Washington, D. C. Proc. of 28th Annual Conv. of Intern. Assoc. Milk Dealers, Plant Section, p. 146, 1935.

Definitions of orange juice and orangeade are given, also, an average chemical composition of orange juice. The details of the commercial preparation and preservation of orange juice are given. The author states that carbonated orange beverages now on the market contain from 2 to 10 per cent juice, averaging about 5 per cent. The orange beverages now being distributed by the dairies contain from 10 to 15 per cent juice. Such a high water content, once the public is acquainted with the fact, may reflect upon the quality of the other products distributed by the dairy. The author suggests that the dairy is not primarily in the fruit beverage business and should do nothing to jeopardize its primary interest. He also states that human beings need both milk and orange juice and that dairy orange beverage takes the place of neither.

Vitamin C value of orange juice and orange juice beverages are given as follows:

	Units of Vitamin C per 8 oz. glass	Orange Juice Equivalent
Fresh orange juice	2500	1
Orange juice for dairy trade stored 6 months at 35° F.	2500	1
Dairy orange beverage	200	1/12
Carbonated orange beverage	100	1/25

E.F.G.

Plant Problems in Connection with the Homogenization of Market Milk. R. C. TENNANT, Union Milk Co., Limited Calgary, Alberta,

Canada. Proc. of 28th Annual Conv. Intern. Assoc. Milk Dealers, Plant Section, p. 30, 1935.

The older types of homogenizers should be avoided for milk since they are difficult to clean and the keeping quality of the milk is frequently impaired. The author states that little difficulty with off flavors has been experienced in western Canada when homogenization takes place at 140–145° F. and the pressure kept as low as possible. To avoid trouble from sediment the author recommends mixing skim milk and cream if a clarifier is not available. Some plants have disposed of returns by making a churned buttermilk from a mixture of homogenized and unhomogenized milk which would leave about 2 per cent fat in the buttermilk. One plant in western Canada which attempted to make cheddar cheese from homogenized milk obtained a satisfactory yield but the cheese was weak bodied, short grained and had a tendency to become bitter and stale in flavor. If homogenized milk returns must be separated or churned this may be accomplished with least loss of fat if the homogenizing pressure is kept as low as possible and the separated homogenized cream mixed with unhomogenized cream before churning in a proportion not greater than one to eight. E.F.G.

Standards for Milk Plant Equipment. WALTER D. TIEDEMAN, Com. on Milk Plant Equipment, Intern. Assoc. of Dairy and Milk Insp., Proc. of 28th Annual Conv. of Intern. Assoc. Milk Dealers, Plant Section, p. 124, 1935.

The plan of the committee is to crystallize the opinions of various groups relative to milk plant equipment. Specifications have been drawn by the committee during the last two years. In drawing these specifications some of the factors given weight were (1) public health efficiency, (2) ease of cleaning, (3) effect of flavor and quality, (4) strength and mechanical dependability, (5) appearance. After the first four factors above have been considered then price may be included with appearance. These specifications are not intended as regulations but merely to crystallize opinion so that through agreement of manufacturers of machinery, the milk dealers themselves and milk control officials more uniform and satisfactory equipment may be evolved. E.F.G.

Can Color of Winter Milk Be Improved? W. E. KRAUSS, Ohio Agr. Exp. Sta., Wooster, Ohio. Ohio Exp. Sta. Weekly Press Bul. No. 21, 13, June 4, 1936.

Milk from Jersey and Holstein cows fed acid treated alfalfa-clover silage (A.I.V.) contained almost as much yellow pigment (carotene) as is found in milk from Jersey and Holstein cows on pasture. The desirability of

maintaining yellow color in winter milk is discussed from several angles, including the health of the cow and her calf, human health, and sales appeal.

W.E.K.

The Influence of Feed Upon the Composition of Milk. NAT. M. ALLEN, Univ. of Minn., St. Paul. Proc. of 28th Annual Conv. Intern. Assoc. Milk Dealers, Production Section, p. 69, 1935.

Experiments at the University of Minnesota in 1931 and 1932 have shown that the addition of a number of common animal and vegetable fats including butter fat, lard, tallow, linseed, cottonseed, soybean, corn, peanut and cocoanut oils will result in an increase in the fat content of the milk. The results were so clear-cut that it was possible to determine accurately by milking at frequent intervals almost the exact time required after the fat was fed for its influence to appear in the milk and for this influence to disappear when the feeding of fat was discontinued. Briefly, the experiments showed it was possible to secure as much as 20 per cent increase in butter fat percentages and butter fat production by increasing the daily fat intake one pound or more. While no attempt was made to determine whether the higher fat yields would be maintained indefinitely with continued higher fat intake there was no indication of a return to the normal level after periods of as long as six weeks on the higher level of fat intake.

Recent medical and nutritional research has indicated that the highly unaturated fatty acids occupy an important place in the diet. Under ordinary conditions milk fat is deficient in the fatty acids with two or more double bonds. In dealing with a special grade of milk it is not inconceivable that the type of ration might be considered in improving the nutritive properties of the milk fat in this respect.

E.F.G.

The Disposal of Dairy Waste Waters. GEO. W. CAMANAUGH, Cornell Univ., Ithaca, New York. Proc. of 28th Annual Conv. of Intern. Assoc. Milk Dealers, Plant Section, p. 131, 1935.

A description is given of two 10,000 gallon storage tanks used to precipitate the protein material from dairy waste. A prepared mixture of four parts by weight of ferric sulphate and three parts of finely ground limestone gives quite satisfactory results as a precipitant. The ferric sulphate was purchased at \$40.00 per ton, and one pound of the mixture was sufficient to clarify 1000 gallons of the waste water from a milk shipping plant. The sludge which on a dry basis had 7 per cent of nitrogen and a high fertilizing value was removed by drawing into tank wagons.

E.F.G.

Titratable Acidity as Influenced by Corn Gluten Feed. E. O. ANDERSON AND G. C. WHITE, Storrs, Conn. Proc. of 28th Annual Conv. Intern. Assoc. Milk Dealers, Laboratory Section, p. 107, 1935.

Two series of trials were conducted using a ration containing 70 per cent corn gluten in the grain mixture compared with a control ration. In the first trial the periods were 20 days each (reversal feeding trial) with a five day interval between periods. No increase in titratable acidity was obtained in the corn gluten ration.

The second trial, continuous feeding for as much as 131 days, failed to increase the titratable acidity. Considerable variation in acidity of the milk from different animals was obtained.

Individuality is an important factor in determining the titratable acidity of freshly drawn cow's milk and accounts for more of the variation in the acidity of such milk than the grain ration. E.F.G.

Properties of Amylase of Cow's Milk and its Relation to the Chief Constituents of Milk. ALFONS SCHLOEMER, German Research Inst. for Food Chem., Munich, Germany. *Milchw. Forsch.* 17, 6, p. 326, April, 1936.

The author determined the amylase in milk from the lead acetate serum. The most favorable conditions for the adsorption of amylase out of lead serum were studied with different adsorption media. The amylase was inactivated by the dialysis of the serum apparently because of the removal of electrolytes, especially the chlorides. Reactivation followed the addition of the latter. The Ca ion in the form of chloride played a special role in reactivation in contrast with all other amylases where CaCl_2 is similar in action to but no stronger than NaCl. The role of ionizable Ca compounds in milk is also considered. The amylase seemed to be most intimately associated with the serum proteins. A method for obtaining milk amylase is described. H.M.

Part I. The Effect of Bang's Disease on Milk Production. ALEXANDER GOW, JR., AND A. B. HAMILTON. **Part II. Udder Infection in Bang's Disease,** C. L. IVERSON, L. J. POELMA AND A. L. BRUECKER. Maryland Agr. Exp. Sta. Bul. 387, Oct., 1935.

Part I comprises a statistical study of the effect of Bang's disease on milk production of nine herds over a period of four years.

The yearly average for the four years shows there was an increase in income of the non-infected group of \$22.35 per cow over that from the infected group.

The milk production for each of the non-infected cows during the four-year period was 6,844 pounds per year with a butter fat content of 281.6 pounds, in comparison with 6,330 pounds of milk and 251.6 pounds of fat from each positive cow. The calvings were at the rate of 1.07 per cow-year in the non-infected group and 0.86 per cow-year for the infected group.

Part II. None of the cattle from which samples were collected, in so far as it was possible to determine, had been infected experimentally or injected with *Brucella abortus* in any form. Cattle which had shown an agglutination reaction on a previous test were chosen as a source of the material. The titres of these animals ranged from a partial at 1 to 25 to a complete reaction at 1 to 200 or higher. Composite samples from the functioning quarters were chosen as suitable materials for determinations. After thorough mixing of the milk sample, portions were withdrawn for the agglutination test and animal inoculation. The blood and milk sera were tested for agglutinins using *Brucella abortus* antigen. Each of two guinea pigs was inoculated subcutaneously with 3 cc. of butter fat and sediment from each sample. All guinea pigs were allowed to remain on test for six weeks, at which time they were destroyed. Blood samples were obtained and the pigs autopsied and lesions destroyed. The presence of *Brucella abortus* agglutinins in the blood serum of the inoculated guinea pig was taken as positive evidence of the presence of *Brucella abortus* in the udder secretions, regardless of whether lesions were present or *Brucella abortus* was recovered from the liver and spleen.

The authors concluded that (1) A high serum agglutination titre was more indicative of udder infection than was a high blood serum titre, (2) Milk serum negative for the agglutination test did not indicate freedom from udder infection, (3) *Brucella abortus* organisms were not found in the milk from any cow whose blood serum did not show agglutinins. C.W.E.

The Quality of Philadelphia Market Milk. H. C. CAMPBELL, GEORGE JAGGARD, AND D. W. CRISMAN, The Dairy Laboratories, Philadelphia, Pa. Milk Dealer 25, 10, p. 50, July, 1936.

The purpose of this paper is to show the tendency toward high or low results as judged from a few samples in one area. The following conclusions are drawn:

1. *B. coli* content of the four grades of market milk are given, which should aid in suggesting practical limits for the different grades of milk, although the small number of samples run should be carefully considered.

2. Assuming that the sporogenes test is indicative of the original care shown in production, the findings show the milks are graded as we would expect—Certified, first; inspected raw, second; grade A pasteurized, third, and grade B pasteurized, fourth, with appreciable differences between the certified and inspected raw and likewise between grade A pasteurized and grade B pasteurized.

3. Incubation on nutrient agar at 32° C. as judged by this survey on 30 samples of each group would not seriously alter the grade of any of the four market milks.

4. Substitution of trypsin digest skimmilk agar for nutrient agar and incubation at either 32° or 37° C. as judged by 30 samples of each group.

(a) Would increase the counts of certified milk approximately 50 to 60 per cent although this increased average is only 36 per cent of the maximum allowed.

(b) Would concern the producers of inspected raw milk as the average counts are above the 20,000 requirement for inspected raw milk.

(c) Would cause occasional samples of grade A pasteurized milk to exceed the 30,000 requirement. Average counts are increased 135 per cent although the increased average is approximately 10,000.

(d) Would materially raise the counts on grade B pasteurized milk and cause occasional samples to fail to meet the requirement, although the averages are approximately 20,000 at 37° C. and 30,000 at 32° C. C.J.B.

Methods of Control Infectious Bovine Mastitis. E. O. ANDERSON AND W. N. PLASTRIDGE, Storrs Agr. Exp. Sta., Storrs, Conn. Proc. of 28th Annual Conv. Intern. Assoc. Milk Dealers, Production Section, p. 75, 1935.

A study of 300 strains of streptococci from healthy and diseased udders show that the streptococci isolated from the bovine udder may be divided into the following three principal groups. (1) A group containing saprophytes only, (2) one designated as Group B which is associated with a mild form of mastitis of relatively short duration, and (3) a group designated as Group A or *Streptococcus mastidis* which was responsible for at least 90 per cent of the instances of persistent chronic mastitis in the herds under study. A satisfactory method upon which to base the segregation of infected animals must include identification of the species or type of organism found.

This paper is concerned with the incidence of mastitis in bacterin-treated and untreated groups and the presentation of a plan for the control of infectious chronic mastitis by periodic laboratory examinations and segregation of affected animals. A review of past work in this field is presented and an outline of experimental methods given.

In general, the results obtained with bacterins show that (1) periodic injections of autogenous herd bacterins fail to bring about complete recovery of affected animals; (2) they reduce but slightly the rate of spread of infectious mastitis, and (3) they apparently aid somewhat in retarding the occurrence of milk abnormal in appearance by animals recently affected with the disease.

Determination of the relation of the lactation period to evidence of mastitis in two badly affected herds showed that the incidence of laboratory evidence of mastitis, shedding of streptococci and yielding of milk abnormal in appearance increased at a fairly uniform rate with each succeeding lactation period. First calf heifers were usually free from mastitis for several months following parturition. Thereafter the incidence of mastitis increased steadily until all animals that reached the ninth lactation period

gave consistently positive evidence of mastitis by laboratory tests and yielded milk abnormal in appearance at irregular intervals.

The plan of control submitted is briefly as follows:

Examination of the milk of individual cows by eight different tests permits placing the milking animals of the herd in five groups, the first classed as negative and the last containing animals showing positive evidence of mastitis due to Group A streptococci. First calf heifers added to the herd are placed at the head of the list in Group I. Mature animals calving after the initial test are not added to the milking herd until samples of milk have been examined. Animals in the last group are disposed of as rapidly as possible. The authors state that results thus far indicate that infectious mastitis may be effectively controlled by this method. One herd established over 2 years ago failed to show the presence of either group A or Group B streptococci in bacteriological tests made at 30-day intervals. A modified plan is proposed when laboratory facilities are not available.

E.F.G.

Results of Bacteriological Survey of Milk Jugs and Milk Bottles. S. V.

LAYSON AND E. G. HUFFER, Ill. Dept. of Health, and J. M. BRANNON, Univ. of Ill. *Milk Plant Mo.* 25, 2, 1936.

Methods of operating bottle washers and handling bottles following washing were largely responsible for high bacterial counts, both in jugs and in bottles rather than the machines themselves. Figures are presented showing that jugs and bottles can be put in good condition bacteriologically. Also, that the bacteriological condition of many jugs and bottles is such that they should not be filled with milk.

G.M.T.

Comparative Fairness of Single Can and Weigh Vat Samples for Bacterial Counts Used as Basis of Premium Payments to Grade A

Dairymen. M. W. YALE AND R. S. BREED, N. Y. State Agr. Exp. Sta., Geneva, N. Y. *Proc. of 28th Annual Conv. Intern. Assoc. of Milk Dealers, Laboratory Section*, p. 94, 1935.

Eleven hundred samples from 178 dairies were collected at 3 Grade A New York plants. In 13.2 per cent of the 178 cases the dairyman had a chance of obtaining a better premium with a combination of a P. M. and A. M. can than with the weigh can sample while in 24.5 per cent of the cases he has a poorer chance of obtaining the same premium. However, at two of the three plants the number of cases in which the vat sample was more severe just about equaled the number of cases in which it was more lenient, so that the above differences in percentages are probably not significant. In measuring the effect of residual milk in the weigh tank 36 cases out of 178 (20.2 per cent) yielded counts in which composite samples from cans placed the milk in a different premium class than those from the weigh can. In 16

instances vat counts were in a lower premium class than composite samples from cows and in 20 instances in higher premium classes. It was concluded that the routine standard plate counts were not sensitive enough to measure contamination of the vat sample with residual milk. In a second study 197 samples were taken from 48 dairies. From these it was concluded that very careful technique with triplicate agar plates indicated that the counts measured weigh vat contamination to a slight degree.

In the above work only 2 cases of counts over 100,000 were obtained, one occurring in each of the two studies.

While some indication has been obtained that a change from single can to weigh vat samples will have but little effect on total premium returns and that premiums are seldom lost through contamination of the vat sample with milk from the preceding dairy, definite conclusions are not justified at this time. At least a year of vat sampling would be needed to determine this. Errors in plate counts are greater than are desirable in a method used as a basis of payment. Changes in laboratory methods should be made which will reduce errors in bacterial counts to a practical minimum and which will more nearly indicate the true quality of the milk delivered by the dairyman.

E.F.G.

Facing the Facts on High Temperature Pasteurization. GEO. W. PUTMAN, The Creamery Package Manufacturing Co., Chicago, Illinois. Proc. of 28th Annual Conv. of Intern. Assoc. Milk Dealers, Plant Section, p. 138, 1935.

High temperature pasteurization was first tested and accepted by the Pennsylvania State Health Department in 1927. A census by Irwin, of the Pennsylvania State Health Department, showed 76 plants are now using either the electric or hot water type of high temperature pasteurizers. Advantages of this method of pasteurization include lower initial investment in equipment, smaller floor space, and some saving of time in cleaning. Also bottling can be started earlier.

The disadvantages include the following:

The very narrow margin between effective pasteurization and injury to cream layer, the destruction of cream layer on a considerable quantity of milk before and after shut down, the higher milk temperature may result in more metal being dissolved which in turn may increase a tendency to cappy flavor; milk stone accumulations are greater and more difficult to remove; specifications by the U. S. Public Health Service relative to automatic controls render practical operation more difficult. For various reasons, some of which have been enumerated above, eight plants which have come to the author's attention have discontinued high temperature pasteurization.

Each leader contemplating high temperature pasteurization should carefully consider how this process will fit into his own plant operations before making a decision.

E.F.G.

A Study of Sanitary Quality of Milk Unsupervised Sources in Illinois.

H. A. RUEHE, Univ. of Illinois, Urbana, Ill. Proc. of 28th Annual Conv. Intern. Assoc. Milk Dealers, Production Section, p. 3, 1935.

This study, a cooperative one between the University of Illinois and the State Department of Agriculture, was to determine the quality of raw milk being sold throughout the state outside of those cities which have satisfactory milk control ordinances. The samples were taken in 54 counties in the northern two-thirds of Illinois from November, 1934, to February, 1935, inclusive. Of 1,720 samples, 41, or 2.38 per cent, were below the legal standard of 3.0 per cent fat, while 71, or 8.58 per cent, were below the legal standard of 8.5 per cent solids-not-fat. Of the 1,720 samples 417, or 24.24 per cent, contained at least 5.0 per cent fat, while of the 827 samples, 146, or 17.65 per cent, contained 9.5 per cent and over of solids-not-fat.

Bacterial counts on 1,713 samples showed 227, or 12.80 per cent, below 10,000 per cc. and 150, or 8.47 per cent, above 1,000,000 per cc.

The sediment tests on 1,493 samples indicated that about half the milk was being filtered through sanitary pads and half through wire or cloth strainers.

Agglutination tests on 1,424 samples gave 20.01 per cent positive. The presence of streptococci causing mastitis was demonstrated in 15.11 per cent of 728 samples. Positive tests for *Escherichia coli* were obtained on 20.97 per cent of 372 samples.

The author considers that the food value of the samples examined does not present a problem but that there is a positive health problem in the results of the abortion, mastitis, and coli tests. E.F.G.

Significance and Control of Intestinal Bacteria in Milk Products. O. K.

PALLADIA AND T. A. KROTOWA. Central Fat Inst., Leningard, U. S. S. R. Milchw. Forsch. 17, 5, p. 212, Dec., 1935.

Eberthella typhosa, *Salmonella schottmuelleri*, *Escherichia coli*, *Aerobacter aerogenes* and a food-poisoning bacillus called *B. Breslau* (*Salmonella enteritidis*?) alone or in combination with lactic acid rods or cocci, grow well in milk. An acidity equivalent to pH 4.2 is critical for these types although they survived for considerable periods at a higher pH. With a combination of 5 per cent NaCl at pH 4.6, the intestinal types were destroyed within 24 hours. During the manufacture of butter and margarine, the intestinal types increase steadily, so in order to control them the authors recommend rapid souring of cream and prompt salting of the butter.

H.M.

Seasonal Influences on the Quality of Milk and Some Methods Serving for their Estimation. KARL ECKL, Dairy School and Research Station, Friedland, Germany. Milchw. Forsch. 17, 5, p. 193, Dec., 1935.

Bacterial counts were made on 937 samples of milk. Marked seasonal fluctuations were shown by total counts on China blue lactose agar with incubation at 30° C. for 4 days plus 1 day at room temperature, methylene blue reduction time, fermentation tests at 38° C. for 24 hours and *E. coli* tests by Neisser and Frieber indol method. High counts prevailed and the lack of prompt and efficient cooling was evident. The various tests were subject to discrepancies at certain seasons and the authors emphasize the importance of selecting the proper test for the particular season involved.

H.M.

Contributions to the Biochemistry of Microorganisms. VII. Knowledge of *Bact. linens*. W. GRIMMER AND JOSEF SCHMID. Univ. of Königsberg, Germany. *Milchw. Forsch.* 17, 6, p. 286, April, 1936.

Data are presented on the decomposition of casein, in the presence or absence of dextrose, by *Bact. linens* Weigmann, a species isolated from the slime of Tilsiter or Limburger cheese.

H.M.

Influence of the Nutrition Medium and Oxygen Tension on the Acid and Alkali-forming Ability of Slime-formers of the *Aerobacter* Group. JOHANNES RODENKIRCHEN, Univ. of Königsberg, Germany. *Milchw. Forsch.* 17, 6, p. 303, April, 1936.

Slime-forming cultures, closely related to *Aerobacter aerogenes* and *A. cloacae*, considered as strong alkali-producers on the basis of their action on China blue lactose agar, formed only acid as a rule in lactose broth under anaerobic culture and in milk under aerobic or anaerobic conditions. The same types usually exhibited a marked reducing action in China blue milk but in China blue lactose broth reduction repeatedly appeared simultaneously with alkali formation. The importance of medium and oxygen tension in determining the biochemical activities of bacteria is emphasized.

H.M.

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ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

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ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

BUTTER

Creamery Business Analysis. L. L. ULLYOT AND H. F. HOLLANDS, Div. of Agr. Ec., Univ. of Minn., St. Paul, Minn. Minn. Agr. Exp. Sta. Bul. 322, April, 1935.

The authors present an analysis of the business of 117 Minnesota cooperative creameries. The purposes of the bulletin are to indicate the general types of information that should be included in an annual creamery report, to show patrons and other persons how to analyze and interpret such a report, and to indicate the general financial condition and the operating efficiency of the cooperative creameries included in the study.

An annual report should provide the specific information needed to determine, first, the financial status of a business, and, second, the results of the year's business operations. To serve these two purposes adequately, the report must contain the following three statements:

1. A balance sheet, which is a statement of the financial conditions of a business at the time the annual report is made.

2. An operating statement, which shows the various sources of income and the kinds of expenses incurred.

3. A statistical statement, which shows the quantities of commodities handled and the average prices received and paid for these commodities. From these data may be determined such information as the per cent of overrun and the expenses per pound of butter made. S.T.C.

CONCENTRATED AND DRY MILK

A Method to Obtain the Desired Fat Content of Dry Milk. J. BRABEC. Mlekarske Listy 27, 231-2 (1935); Chem. Obzor II, Abstract sect. 74.

The desired fat content of dry milk can be calculated according to the formula $t = \frac{T}{95 - T} \left(0.09 + \frac{t' + L}{4} \right)$ where T is percentage of desired fat content, t' the fat content of milk used, t the fat content to which the milk must be standardized before drying and L is the value found by the lactometer. J.J.K.

Dry Skimmilk—How to Use It. ALICE M. CHILD, Div. of Home Ec., Univ. of Minn., St. Paul, Minn. Minn. Agr. Exp. Sta. Bul. 313, Dec., 1934.

In homes where the amount of milk is limited by the cost, the necessity for economy often results in an insufficient milk supply. By the use of dry

skimmilk in cooking and whole milk for drinking, it is possible to bring the total milk consumption to the desired amount. When dry skimmilk is used in place of part of the necessary milk supply, certain food materials must be added to the list to take the place of butterfat in building up a strong resistance to disease.

Directions and tested recipes for the use of dry skimmilk in home and quantity cookery are given. S.T.C.

CHEESE

A Study of the Bacterial Flora of Foremilk and of Rennet Extract, With Special Reference to Acid-proteolytic Types. M. R. KNOWLES, Agri. Bact. Dept., Univ. of Reading. *J. Dairy Research* 7, 1, p. 63, Jan., 1936.

A relatively small number of acid-proteolytic cocci was found in the foremilk obtained aseptically from our healthy cows. Of 58 cultures of cocci isolated only four types were capable of digesting casein under acid conditions brought about by their own activities, namely, *Staphylococcus* sp., *S. liquefaciens*, *Micrococcus caseolyticus*, *M. freudenreichii*. Only the first two were vigorously acid-proteolytic. Gelatin was liquefied by 87.3 per cent of these cultures and 23.7 per cent were acid-proteolytic in milk. Of the gelatin liquefiers only 27.1 per cent liquefied milk. The remaining strains, however, may aid in the final breakdown of split-protein products in ripening cheese.

Rennet extract contained a varied flora of proteolytic cocci that under normal conditions would gain entrance into the cheese. The types found in fresh extracts were similar to those found in the foremilk and it is considered likely that the organisms in the rennet extract are the same organisms transplanted from the udder of the cow to the stomach of the suckling calf and thence to the rennet extract. In the samples of old rennet many contaminating types of organisms were found, including yeasts, molds and actinomyces. H.A.B.

The Varieties of Cheese in the International Market. JAR. DVORAK. *Mlekarske Listy*, 26, 12, 29-31 (1934); *Chem. Obzor* II, Abstract sect. 73.

A review of the original varieties of cheeses manufactured in various countries, with data on milk and fat composition elaborated by the International Cheese Commission at the federation in Brussels. J.J.K.

Lattopect. L. HERTL. *Mlekarske Listy* 27, 210-2 (1935); *Chem. Obzor* II, Abstract sect. 74.

Lattopect, a fruit pectin used in milk products, when used in small amounts (2 per cent) improves the cheese and prevents drying out. J.J.K.

(Conservatives) Preservatives for Melted Cheese. K. KOUTNY.
Mleflarske Listy 27, 6-10 (1935); Chem. Obzor II, Abstract sect. 74.

The preservatives (benzoic acid, sodium benzoate, etc.) should not be used for melted cheese. J.J.K.

ICE CREAM

Drum vs. Spray Process Dry Milk in Ice Cream. R. L. CARITHERS AND W. B. COMBS, Univ. of Minn., St. Paul, Minn. Ice Cream Rev. 19, 8, p. 42, March, 1936.

Dry milks were prepared by the spray process and the atmospheric drum process for use in ice cream. Preheating of skimmilk manufactured into drum process dry milk to temperatures of 63° F., 145° F., and 185° F., had no effect upon the quality of ice cream made using these dry milks. It was not possible to detect any difference in the quality of ice cream made using fresh dry skimmilks prepared by the spray process and the drum process as compared with ice cream made using plain condensed milk. After storing the dry milks for six months, however, the flavor of those made by the drum process dried milk carried over into ice cream to such an extent that it had a decided detrimental effect on the flavor. J.H.E.

Causes of Sandiness in Ice Cream in the Winter Months. H. H. SOMMER, Univ. of Wis., Madison, Wis. Ice Cream Rev. 19, 8, p. 44, March, 1936.

Slower turnover of ice cream in winter is not the only reason for the greater likelihood of sandiness in winter. If no change is made in the mix formula as the colder months of the year approach, the serum solids content of the mix will actually be higher than during the summer months, due to the fact that the solids-not-fat content of milk is higher in winter months. A formula for arriving at the serum solids content that may be safely used is given. J.H.E.

Effect of Freezing and Homogenization on the Colloidal Stability of Mixes. H. H. SOMMER, Univ. of Wis., Madison, Wis. Ice Cream Rev. 19, p. 3, p. 56, Oct., 1935.

The colloidal stability of ice cream mixes is becoming increasingly more important with the introduction of two-stage homogenization and continuous freezers. Homogenization and freezing are recognized as destabilizing factors in the case of emulsions and colloidal sols. If the mix is not sufficiently stable the ice cream on melting is likely to present a curdy and wheyed-off appearance. This defect is associated with the ability of proteins to retain water. The author reviews the work of Hans Mumm which indicates that hydration of casein increases on either side of the isoelectric point. This

would mean that the ability of milk proteins to retain water decreases as the acidity increases. The finding that previous high temperature treatment increases the hydration of casein suggests that mix pasteurizing temperatures have an effect on the ability of the milk proteins to retain water in ice cream. J.H.E.

Ice Cream Mix As a Solution. H. H. SOMMER, Univ. of Wis., Madison, Wis. *Ice Cream Rev.* 19, p. 46, Dec., 1935; *ibid.*, 19, 6, p. 62, Jan., 1936; *ibid.*, 19, 7, p. 66, Feb., 1936.

The author states that a full understanding of whipping ability, mix viscosity, fat clumping, shrinkage of ice cream, crumbly body, sticky body and serum drainage or curdled appearance of the melted ice cream require the proper conception of the mix as a solution. In these three articles the mix constituents are classified and discussed according to their state of suspension. It is pointed out that the milk proteins and stabilizers exist in the mix in the form of colloidal suspensions and the fat exists in the form of an emulsion. In the case of the fat emulsion the size of the globules, the nature of the adsorption film which surrounds them, and the electric charge carried by them determine the behavior of the emulsion. In the case of the colloidal protein suspensions, the colloidal particle size, their hydration and the electric charge carried by them determine their stability.

The electric charge on the suspended particles in both cases play a very important part in determining their physical behavior. Factors discussed as affecting the charge on the colloidal protein particles in milk and in ice cream mix are as follows: (1) acidity, (2) salts (ions), (3) temperature, (4) previous heat treatment, (5) rennin action.

The observed destabilization of proteins by freezing may be due to increased acidity, increased salt concentration, a changed ion concentration with the positively charged ions more predominant, a shift in the isoelectric point of the proteins, and/or decreased hydration of the proteins. Destabilization occurs only insofar as aggregation of the particles occurs. As freezing progresses, decreased kinetic energy and increased viscosity make aggregation more difficult. On this account quick freezing has less destabilizing effect than slow freezing for in slow freezing the product lingers longer in the zone of maximum instability. J.H.E.

Sherbets—How to Improve Them. W. C. COMBS, Univ. of Minn., St. Paul, Minn. *Ice Cream Rev.* 19, 6, p. 38, Jan., 1936.

The author reviews the observations that were made on 19 sherbets exhibited from various parts of Minnesota and the Northwest. Considerable variation in total solids and acidity was observed. The total solids content averaged 32.9 per cent. The range was from 26.8 to 39.4 per cent. The acidity of the sherbets, expressed as citric acid, ranged from 0.27 to 0.75 per

cent with an average of 0.43 per cent. The sherbets graded good or very good, had an acidity of not more than (or slightly above) 0.45 per cent and a total solids content of not below 30 per cent.

Careful standardization of composition and acidity are recommended. Sherbets should not be whipped in the freezer to contain more than 40 per cent swell. Best results will be secured by reducing the amount of sherbet in the freezer and adopting methods of freezing conducive to quick freezing. A small amount, three per cent, of sodium caseinate added to sherbet has been observed to bring about marked improvement in body and texture. (The manufacture of frozen deserts with sodium caseinate is patented.)

J.H.E.

This Special Mold Business. (No author given). *Ice Cream Rev.* 19, 5, p. 30, Dec., 1935.

The history and development of the ice cream mold is given as well as the procedure for designing and manufacturing metal molds.

J.H.E.

Recent Legislative Trends as They Affect the Ice Cream Industry.

EDWARD THOM, Assoc. Editor, *Ice Cream Rev.*, Milwaukee, Wis. *Ice Cream Rev.* 19, 9, p. 40, April, 1936.

Recent state laws dealing with pasteurization of ice cream mix and overrun control of ice cream are reviewed. There is growing sentiment among health officials that ice cream, susceptible to contamination much as milk is, should be handled as milk is.

J.H.E.

Operating the Refrigeration System Economically. F. B. GILBERT, Res.

Engineer, The Creamery Package Manufacturing Co., Chicago, Ill. *The Dairy World*, 15, 2, p. 41, July, 1936.

The author discusses ways and means of checking the efficiency of operation of a refrigeration system, pointing out the symptoms and causes of some of the common maladjustments encountered in commercial dairy plants. By comparing temperatures and pressures on the suction and discharge lines with theoretical tables or charts indications of inefficient operation are obtained and the causes can be ascertained by simple elimination. Generally speaking any change in the operation of the system which causes head pressures to rise or suction pressures to decrease will result in more power cost per ton of refrigeration. Proper maintenance of condensers, evaporators and storage rooms is also briefly considered as well as the amount and purity of the ammonia in the system.

F.J.D.

Heat Insulation. HARVEY B. LONDSAY, Dry Zero Corp., *Ice and Refrig.* 90, 3, p. 194, March, 1936.

Conduction is the major means of heat travel through cellular and interstitial materials. The transfer of heat in a gas filtered space is a function

of the molecules of gas in the space. The nature of their action is the same whether a small number is confined in a small space or a large number confined in a larger space. Heat affects the movements of these molecules. The higher the heat load the greater is this heat agitation. The flying molecules rebound very rapidly from a smooth hard surface, and are gone before they can accumulate a heat load. In the case of a soft surface they are momentarily imbedded while in the case of a rough surface they may ricochet from surface to surface. Thus they pick up a greater heat load and surfaces of the latter two types tend to increase the rate of heat transfer.

Moisture in the insulating material greatly affects its efficiency. Thus far no effective method of keeping moisture completely out of insulation has been developed. Data are included to show how household refrigerators insulated with a non-hygroscopic insulation lost but 7 per cent in efficiency in the same period.

L.C.T.

MILK

Effect of a Milk Plant Quality Program on the Price Paid to the Producers for Milk. V. C. MANHART, Dept. of Dairy Husb., Purdue Univ., Agr. Exp. Sta., Lafayette, Ind. Purdue Exp. Sta. Bull. No. 404, 1936.

A four year study of a milk quality program as used by an Indiana milk plant was made to determine the equitableness of the program to producers. The program was based on a grading system in which the grades of milk were determined by flavor, the methylene blue test, and the sediment test.

The results show that the program was "undoubtedly equitable to all producers and decidedly advantageous to a large majority of the producers." Most of the producers secured larger returns under the program than they would had they sold their product at the prevailing market price without regard to grade.

B.E.H.

Milk Quality Improvement Effected at the Farm by a Plant Program. V. C. MANHART AND A. V. MOORE, Dept. of Dairy Husb., Purdue Univ., Agr. Exp. Sta., Lafayette, Indiana. Purdue Exp. Sta. Bull. No. 405, 1936.

This bulletin describes a simple, inexpensive milk quality program as put into effect by an Indiana dairy plant. Three grades were established; premium, regular and low. The milk was first graded at the plant on flavor and the objectionable flavored milk was either rejected or placed in a low grade without further testing. Satisfactory flavored milk was subjected to the methylene blue and sediment tests and the grade was determined by these tests.

The authors summarize the benefits derived from the program as follows:

"The milk plant received a better quality milk which when sold as fluid milk commanded a price of more than one cent a quart higher than the prevailing price for pasteurized milk in the same market.

"The consumer received a good quality milk, wholesome in nature, pleasing in flavor, and with a total bacterial count of less than 10,000 per cc. after pasteurization and at the time of delivery.

"The producer of premium milk received a premium of about 4.5 cents per pound milk fat which represented an increase of more than 17 per cent over the prevailing price paid in the territory. Furthermore this benefit was received by a majority of the producers.

"In view of the foregoing considerations, the quality program reported herein is recommended to milk plants as highly satisfactory for the improvement and maintenance of quality in the raw milk supply." B.E.H.

A National Yardstick of Milk Quality Factors. RUSSELL J. DAVIS. Milk Dealer 25, 11, p. 36, August, 1936.

The author discusses the present lack of knowledge of the difference between the various grades of milk. He contends that due to the present haphazard understanding of milk quality, a national yardstick, a "common denominator" of quality factors, is needed if a uniform understanding of milk quality is to be gained and sales of the better milks of all grades are to be increased. A yardstick of quality factors is presented. C.J.B.

Milk Consumption Increasing in New York Metropolitan Area. Milk Dealer 25, 11, p. 86, August, 1936.

A report of milk consumption in the New York metropolitan area is shown by a study made by the Milk Research Council. C.J.B.

The Determination of Lactose and Glucose in Milk. TUDOR STANLEY AND GEORGE JONES, Nat. Inst. for Res. in Dairying, Univ. of Reading. J. Dairy Research 7, 1, p. 41, Jan., 1936.

The presence of glucose in milk has been difficult to determine due to methods of analysis. In this experiment glucose was determined in milk with remarkable accuracy as the reducing material removable by washed yeast at a neutral or slightly acid reaction. The washed yeast was found not to ferment lactose and did not add reducing material to tungstic filtrates.

Typical results obtained by this method was as follows:

Total reducing sugar 4.52 per cent, lactose 4.36 per cent, glucose 0.08 per cent for a normal cow.

Total reducing sugar 4.20 per cent, lactose 3.98 per cent, glucose 0.11 per cent for a cow late in lactation. H.A.B.

Determination of the Quality of Milk from Its Specific Gravity and Fat Content with Lactonogram. Byichin. Sbornik Ceskoslov. Akad. Zemedelske II, 220-7 (227 in French and Russian), 1936.

Various methods of determination of quality of milk and its composition are reviewed and the use of specially composed lactonograms (a graph from which total solids may be read if the fat content and lactometer readings are known) is suggested giving total dry matter, dry matter free of fat, fat content in dry matter, and of added water and skimmilk from the specific gravity and fat content of investigated milk. J.J.K.

Determination of Freezing Point of Milk for Testing the Presence of Water in Diluted Milk. Mlekarske Listy 26, 71-3 (1934); Chem. Obzor II, Abstract sect. 73.

The freezing point was found to have a value between -0.59° and 0.50° ; the average = -0.5552° but samples of milk showed variable degrees of supercooling in making the determination. No relation between freezing point and season was found in the months March-June; the freezing of milk was slower in the hot season than in the cold season. J.J.K.

Test for Pasteurized Milk. K. KOUTNY. Mlekarske Listy 26, 246-9 (1934); Chem. Obzor II, Abstract sect. 73.

A review of bacteriological and chemico-biological changes of milk in pasteurizing milk to $60-63^{\circ}$ C. and above 80° C. The milk is tested for short time pasteurization (above 85° for at least 1 minute) by 3 per cent alcohol solution in guaiacol and 1 per cent solution of hydrogen peroxide. An analogous test for long time pasteurization is not known. J.J.K.

Biennial Reviews of the Progress of Dairy Science. Section C, Dairy Chemistry. W. L. DAVIES, Nat. Inst. for Res. in Dairying, Univ. of Reading. J. Dairy Research 7, 1, p. 75, Jan., 1936.

The review records the progress of dairy chemistry for the period extending from the end of that dealt with in a previous review (1933) to August, 1935. The subjects noted as arousing the greatest interest during the last two years are: composition and autoxidation of butterfat, the composition of casein, the physical chemistry of milk and its products and the technology of butter and cheese manufacture.

The review covers the composition of milk, chemistry of milk constituents, physical chemistry of milk and certain factors concerned with butter, cheese, concentrated and dried milk products. H.A.B.

The Effect of Variations in Feeding on Dairy Cows Yielding Milk of Poor Quality. ALICE WATSON STEWART AND JAMES FOWLER TOCHER, the Rowett Res. Inst. and the Univ. of Aberdeen. J. Dairy Research 7, 1, p. 1, Jan., 1936.

To find a practicable means of improving the quantity and quality of the milk produced by cows consistently yielding milk of a solid-not-fat content

studied during three lactations using two Friesian cows, one Guernsey and one Shorthorn Cross cow.

1. Good grazing with a supplementary ration
2. Well balanced normal rations
3. High protein rations
4. High carbohydrate rations

It was concluded that the solids-not-fat content as well as the quantity of milk produced may be slightly raised by improved feeding practices, but that a high solids-not-fat content is principally a hereditary factor. H.A.B.

The Metabolism of Betaine and Allied Tertiary Nitrogenous Bases in the Ruminant. WILLIAM LEWIS DAVIES, Nat. Inst. for Res. in Dairy-ing, Univ. of Reading. *J. Dairy Research* 7, 1, p. 14, Jan., 1936.

The origin of and means of preventing fishy flavors in the milk of cows fed on sugar-beet by-products was investigated. Beet molasses contains on the average 1.5 per cent betaine nitrogen, molasses beet pulp 0.5 per cent, and fresh beet tops 0.03 per cent, so that dairy cows on normal rations containing suitable quantities of these products may be receiving up to 100 grams of betaine per day. These feeds also contain traces of the tertiary nitrogenous bases, choline, trimethylamine and trimethylamine oxide. The tertiary bases, especially betaine, are regarded as the precursors of the fishy taint of milk. The main tertiary metabolite of betaine was found to be trimethylamine oxide, which is more chemically active than betaine itself. With an intake of 100 grams betaine, the peak of trimethylamine oxide excretion in the urine was found to occur in 4½ hours. The maximum concentration of the oxide in the blood probably occurs shortly before the peak of excretion in the urine is reached. Consequently, beet products should be fed as far away from the subsequent milking time as possible, preferably after milking. The mechanism of the development of the fishy taint in milk by interaction of the precursor with one or more of the milk constituents, is being investigated and the work will be reported in a later paper.

H.A.B.

The Chlorine Content of Milk as an Indication of Mastitis. J. W. BLOOD AND A. ROWLANDS, Midland Agri. Coll., Sutton Bonington, Loughborough. *J. Dairy Research* 7, 1, p. 47, Jan., 1936.

The authors studied the reliability of various methods of chlorine determination as means of detecting mastitis in cows. They found that the direct titration of chlorine in milk with silver nitrate solution, without the removal of proteins, always yielded high results. With 10 ml. milk, 40 ml. distilled water and 10 drops of potassium chromate used in the titration with 0.1 N silver nitrate, the results were 25 per cent high and the endpoint was poor. With 10 ml. of milk, 80 ml. distilled water and 2 ml. potassium chromate, the results were still 15 per cent high, although the endpoint was improved.

Three other methods in which the protein was removed or destroyed first yielded comparable and reliable results. However, the arbitrary standard of 0.14 per cent chlorine fixed by Rosell as the maximum content of normal milk was not found justifiable, because cultural examinations often revealed no evidence of mastitis when a chlorine content above this limit was found and infected udders at times yielded milk with a chlorine content within the range of normal milk, *i.e.*, 0.07–0.12 per cent.

H.A.B.

Note on the Sulphydril Compounds of Milk. CHRISTOPHER JAMES JACKSON, Dept. of Biochem., Univ. of Alberta, Edmonton, Canada. *J. Dairy Research* 7, 1, p. 29, Jan., 1936.

Experiments with the nitroprusside test on a large number of milks seem to indicate that there are no sulphydryl compounds in free solution in cow's milk. The occurrence of a positive nitroprusside test in milk treated with sodium cyanide is considered to be due to the cystine in the protein complex.

H.A.B.

Improving Milk Products by Yeast Cultures. O. LAXA. *Mlekarske Listy* 26, 339–40 (1934); *Chem. Obzor II*, Abstract sect. 73–4.

Yeast cultures decomposing milk sugar with the formation of perfume esters improve also the taste of milk.

J.J.K.

Correct Evaluation of the Agglutination Test with Bang Antigen. KARL DIERNHOFFER. *Z. Infektion. Parasitäre Krankheiten Hygiene Haustiere* 49, 2, p. 146, 1936.

This is a discussion of the methods used in evaluating the readings obtained in testing for abortion disease.

L.D.B.

Results of Five Years' Study of Mastitis with Special Emphasis on the Effect of an Artificial Dry Period. OTTO ROEMMELE. *Z. Infektion. Parasitäre Krankheiten Hygiene Haustiere* 49, 2, p. 123, 1936.

From previous investigations of the numerous methods for the certain and rapid identification of mastitis this writer considers none of them is entirely satisfactory. Beeker had found that the laboratory tests were superior to those recommended for field use, but that continued observations of the condition of the udder and characters of the milk by the milker were a more certain means of diagnosing the disease than the tests usually recommended. He suggests that an expert should be able to determine these abnormal conditions according to flavor, odor, and appearance on the same basis on which other products are judged.

The treatment of 826 animals with Entozon once or twice exerted little influence on the course of the disease. However, treatment shortly before the animal ceases to give milk or during the dry period was most suitable for curing the condition. The use of infusions of Entozon, 1 to 500 or 1 to

800, can be used to hasten a cure during the dry period. However, the treatment may be given at any time, but sometimes acts in an unfavorable manner because of the reduced milk flow after the cow freshens again. These recoveries were seldom permanent and may have started because of reinfection.

L.D.B.

Studies on the Infection of the Udder by the Abortion Bacillus of Bang, and Methods for Its Detection. W. STOCKMAYER. *Z. Infektion. Parasitäre Krankheiten Hygiene Haustiere* 49, 1, p. 46, 1936.

The bacteriological examinations started at the time of parturition, using a gentian-violet-malachite green agar, liver agar and other special media, and followed through the lactation period. The experimental animals consisted of 39 cows, previously found to be infected in the udder. The agglutination titers of the blood sera of these cows varied between 1000 and 50,000.

As determined by plate count, the elimination of the abortion bacillus from the infected animals was greatest the first day of lactation, and decreased rapidly during the next two weeks. However, this udder infection may persist throughout the lactation period, or may cease suddenly. In one animal the infection did not start until 10 days after the first calving, but persisted through the second lactation period. The number in some animals reached to 10,000 to 200,000 organisms per cc., but in most instances it was below 2,000 per cc. No doubt there were many more organisms than could be determined by the plate method in all cases. At certain times there was no clinical evidence of an udder infection, and in some animals positive evidence was found only on continued search.

Permanent carriers possessed high agglutination titers of the blood and milk serum. (In the preparation of the milk serum the fat was removed by chloroform). In some animals with negative or low titer agglutinins in the milk serum the organisms were occasionally present. It was evident that the organism might set up an independent infection of the udder. Guinea pig inoculation was the most reliable means of diagnosing this condition, although culturing on the gentian-violet-malachite green agar plates was very satisfactory. Cultural methods were more satisfactory in case the guinea pigs had already become infected from other sources. The use of animals was found to be time consuming (6-8 weeks) and expensive. However, the culture methods used were not widely enough known to be of much importance in detecting such animals. Also the serological reactions were not above doubt since some carriers (chiefly intermittent) might not contain agglutinins in the blood serum or milk serum.

L.D.B.

Can Udder Tuberculosis be Diagnosed by Means of a Cell Count of the Milk? C. EHRlich. *Z. Infektion. Parasitäre Krankheiten Hygiene Haustiere* 49, 2, p. 97, 1936.

The author concluded that: The cell content of milk is much more difficult to determine than that of blood. Many of the cells in milk have disintegrated so that they do not stain readily and are difficult to classify. It is especially difficult to distinguish the epithelial cells and monocytes.

The following classification is offered to differentiate between the cell counts observed in tuberculosis of the udder and mastitis: From tuberculous udder—6.5 per cent lymphocytes 35.0 per cent polymorphonuclear leucocytes, 55.0 per cent monocytes, 3.5 per cent epithelial cells. From a mastitis udder—6.5 per cent lymphocytes, 68.8 per cent polymorphonuclear leucocytes, 22.4 per cent monocytes, 2.3 per cent epithelial cells.

The difference between the appearance of the two preparations is not so evident that they can be used for purposes of differential diagnosis without an analysis of this sort. It is not possible to utilize the same preparations, both for demonstrating tubercle bacilli and cell counting, because of the difficulty in recognizing epithelial and giant cells with high magnifications. The presence of giant cells and groups of epithelial cells are considered to be pathognomonic of udder tuberculosis. This writer found them in 49.2 per cent of the animals investigated. No giant cells of epitheloid cell groups are found in cases of mastitis.

L.D.B.

Detection of Shedders of Streptococci Responsible for Infectious Bovine Mastitis. W. N. PLASTRIDGE AND E. O. ANDERSON, Storrs Agr. Exp. Sta., Storrs, Conn. *Am. J. Pub. Health* 26, 7, p. 711, July, 1936.

The term "shedders" is used to designate lactating animals which eliminate the organism in question through the milk. The following determinations were made on 970 quarter samples from 15 herds: physical appearance, brom thymol blue reaction, leucocyte count, sediment volume, types of colonies on blood agar plates and microscopic examination of incubated samples.

A plan is described for differentiating *Streptococcus mastitidis* (Group A), the common cause of infectious chronic mastitis, from weakly pathogenic (Group B) and saprophytic streptococci of bovine origin.

Microscopic examination of incubated milk samples was found to be the most effective of six methods used in detecting shedders of *Streptococcus mastitidis*. This method revealed the presence of streptococci in 98.7 per cent of the samples collected from animals affected with chronic streptococci mastitis. However, about 13.5 per cent of the samples from healthy quarters also yielded chains of streptococci by this method. It is concluded that the significance of the finding of streptococci in incubated samples from healthy quarters, in the absence of other evidence of mastitis, or during the first 2 and last 4 weeks of the lactation period, can be determined only by isolation and identification of the streptococcus found.

M.W.Y.

Staphylococcus Food Poisoning. Report of a Small Milk-borne Epidemic. H. J. SHAUGHNESSY AND T. C. GRUBB, III. State Dept. of Pub. Health. J. Inf. Diseases 58, 3, p. 318, May-June, 1936.

On the basis of circumstantial evidence, an epidemic of food poisoning involving 25 persons was ascribed to the consumption of raw milk from cows with a staphylococcus mastitis and of ice cream made from such milk. One strain of hemolytic staphylococcus isolated from the milk was shown to produce, under suitable laboratory cultivation, a toxic substance capable of causing vomiting in monkeys and man. Negative results were obtained from feeding experiments with other strains of staphylococci from the milk, but these results were thought to be due to the insusceptibility of some of the monkeys to the enterotoxin.

W.C.F.

A Differential Study of Forty Brucella Strains Isolated in Minnesota.

P. KABLER AND M. MACLANAHAN, Dept. of Pub. Health. J. Inf. Diseases 58, 3, p. 293, May-June, 1936.

The 40 strains of *Brucella* were classified as follows: 25 of *Br. suis*, 13 of *Br. abortus* and 2 with conflicting reactions, one apparently *Br. suis* and the other *Br. melitensis*. The results indicated that in Minnesota *Br. suis* is the etiological agent of human cases of undulant fever about twice as often as *Br. abortus*. The original oxygen tension requirement together with the dye plate growth characteristics gave a fairly reliable means of differentiating the *Brucella* strains, while the agglutinin absorption method was of little or no value. The dyes used in the plates were basic fuchsin, thionin and pyronin.

W.C.F.

Why Frequent Health Examinations of Employees Are Needed. F. W. FABIAN, Dept. of Bact. and Hygiene, Mich. State Coll., East Lansing, Mich. Ice Cream Field 28, 2, p. 9, June, 1936.

The author summarizes his recommendations regarding the health examination of employees in the food and dairy industries as follows:

1. That every employee should be required to take a complete medical examination by a competent physician and submit the necessary samples of blood, feces and urine for laboratory examinations, together with any other tests necessary, at the time he is employed and semi-annually thereafter. If the board of health doesn't require such an examination, the employer should, for his own protection.

2. That supplementing the above examination and as an added protection, all other employees coming in direct contact with food, milk or other dairy products should be examined daily by a nurse, foreman or some other person for evidences of contagious diseases. By means of education and intelligent application, many cases of potential or actual disease may be found in this way.

3. Whether this system or any other is used in trying to find persons suffering with contagious disease, they must not be penalized by being discharged or temporarily laid off without due compensation.

4. Only persons who are inherently clean should be employed in the food or dairy industry. All new employees should be watched carefully until they have been so classified. W.C.C.

Investigation Shows Bacteria in Air May Survive for Days. Milk Dealer 25, 11, p. 47, August, 1936.

A short description of an investigation to determine how long bacteria live suspended in air. The most important conclusion made is that respiratory organisms are apparently "tough" enough to adapt themselves for air transmission, while those of the intestinal tract depend for transmission almost entirely on food and water. C.J.B.

Technique for Obtaining Anaerobic Milk, With Some Observations on Its CO₂ Content. CHRISTOPHER JAMES JACKSON, Dept. of Bioch., Univ. of Alberta, Edmonton, Alberta. J. Dairy Research 7, 1, p. 25, Jan., 1936.

A simple method is described for obtaining milk anaerobically from the udder, for transferring it to an electrode vessel for the determination of oxidation-reduction potentials, and for transferring it to a Van Slyke apparatus for gas analysis. The total amount of CO₂ in cows' milk was found to be about half that of their blood plasma varying from 53.8 vol. per cent to 59.8 vol. per cent in the blood plasma and from 25.8 vol. per cent to 28.7 per cent in the milk of six cows. H.A.B.

Bacteriophage Phenomena in Cultures of Lactic Streptococci. H. R. WHITEHEAD AND G. A. COX, Dairy Res. Inst. (N. Z.), Dept. of Sci. and Ind. Res., Palmerton, North New Zealand. J. Dairy Research 7, 1, p. 55, Jan., 1936.

Bacteriophages were isolated from cultures of lactic streptococci ("starter cultures") and their properties and modes of action described. The presence of phage in a starter culture was first recognized during a renewed investigation of the phenomena of failure in activity caused by aeration of the milk at the time of inoculation. The mother culture would appear normal. A batch of starter prepared from the mother culture in vigorously stirred milk was normal in appearance and acidity, but it failed to produce acid when added to milk in the cheese vat. The same starters in unstirred milk produced acid normally. When a few drops of the active and of the inactive starter were added to tubes of pasteurized milk colored with methylene blue and held at 30° C., both tubes decolorized in 2-3 hours and smears showed copious growth of normal streptococci in both tubes. An hour later, however, the blue color had returned to the tube containing the inactive starter and a smear showed the absence of bacteria. The active starter grew normally and clotted the milk. The lytic agent or phage could be transmitted to

tubes of active young cultures of the susceptible strain by transferring minute quantities of the milk in which the streptococci had undergone lysis.

When a clotted starter culture which was known to be inactive was spread thickly on the surface of yeast whey sugar and incubated overnight at 30° C. the dense, almost confluent growth was dotted with clear circular "plagues." When the same inactive culture was streaked sparingly over the surface of the agar to produce discrete colonies at 30° C., a proportion of the colonies gradually became transparent until only their "ghosts" remained. The phage could be propagated from these transparent colonies.

Purification of the phage was accomplished by adding rennet and calcium chloride to sterile milk which had been inoculated with the susceptible streptococcus and had been phaged in four to five hours by a drop of phaged culture. The whey from the resulting clot was filtered through linen and a sterilized Seitz filter yielding a clear fluid free from bacteria and containing a high concentration of phage, which was kept at 4° C. for several months without significant loss of strength. It was almost completely destroyed by exposure to 70° C. for 30 minutes.

The most striking feature of this phage was its great activity, various preparations giving plaque counts of hundreds of thousands of millions per ml. Its optimum temperature was about 30° C., acting more slowly at 20 and 37° C., so that it might be only slightly active in the starter, but quite active in the cheese milk. Aeration of the milk at 20° C. acted as a "trigger" for phage action. The phage was specific to one strain of streptococci. Quantitative differences in a minor constituent or qualitative differences in a major constituent of milk may also affect the activity of the phage. There was some evidence of the appearance of what are apparently different phages on one strain of bacterium. Attempts to immunize strains of *S. cremoris* against the phage did not prove successful.

H.A.B.

Factors in the Reduction of Methylene Blue in Milk. CHRISTOPHER JAMES JACKSON, Dept. of Bioch., Univ. of Alberta, Edmonton, Canada. *J. Dairy Research* 7, 1, p. 31, Jan., 1936.

It was found that milk drawn anaerobically from the udder of the cow by a specially devised apparatus reduces methylene blue almost instantaneously, whereas the same milk exposed to the air will usually take more than 10 hours for reduction.

The oxidation-reduction potential of milk drawn anaerobically into an air-free electrode vessel, was found also to be lower than the same milk exposed to oxygen.

Milk under anaerobic conditions has only a small oxidation-reduction capacity, indicating that a redox system, present in low concentration, is responsible for the reduction of methylene blue. For that reason, it is suggested that the major constituents of milk, protein, fat and sugar, play no

part in the reduction mechanism, but results indicate that lactoflavin may furnish the redox system.

The addition of small amounts of cysteine or glutathione to milk leads to the reduction of methylene-blue, but these substances were not found present in normal milk.

Light in the visible spectrum catalyzes the reduction of methylene blue in milk.

Bacteria may play but an insignificant part in the reduction of methylene blue in milk, though their de-oxygenating effect may be of influence in the commercial application of the test.

H.A.B.

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